CONCEPT DEVELOPMENT IN CHILDREN III

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III

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Rs 25 - 00

This book is published with the aid of U.G.C. Grant for Publication.

PRINTED AT :
S.V. UNIVERSITY PRESS, TIRUPATI

COPIES : 400

PREFACE

This brief volume presents an investigation of the concept of 'Number' in young children between ages 4 and 7 years. This study is a continuation of the studies of Cognitive Development made at the Department of Psychology, S.V. University, Tirupati. The first two studies were concerned with the development of the concept of Conservation of 'Mass' 'Weight' and 'Volume' in children; and the second focussed on the concept of 'Causation' and the concept of the 'life' in Children. The laboratory work for this was carried out by Dr. G. Nalini Devi, Department of Psychology, S.V. University, Tirupati.

The Publication of this work was made possible under the UGC scheme of publishing learned works. The assistance of University Grants Commission and S.V. University are gratefully acknowledged.

The researchers place on record their deep appreciation of the willing and cheerful cooperation of young children who served as subjects of the investigation.

Thanks are also due to the Headmasters, Headmistresses and their colleagues of the schools which cooperated in this investigation. The authors are deeply beholden to Professor Durganand Sinha for kindly writing the Foreward to this book. Last but not the least, is to acknowledge the cooperation of the parents of the children without whose help and sympathy it would not have been possible to test the children elaborately.

Our thanks are due to Mrs. S.K.N. Rao, M.A., and Miss S. Sujita Sangamitra, M.Sc., for going through the manuscript and the proofs.

The researchers acknowledge the interest and co-operation of the S.V. University Press and wishes to thank the Manager and the Foreman for their excellent work.

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FOREWORD

In recent years, no other scholar has exerted greater influence on cognitive and developmental psychology than Professor Jean Piaget. His assumption that conceptual attainment evolves through sequential stages has been studied by a large number of researchers all over the world. His experiments on ability to be aware of the invariant properties of objects in the face of physical transformations (i.e., conservation) have been extremely popular. While some have tried to analyze the correlates of conservation ability, most studies have implicitly or explicitly been concerned with the question whether the cognitive development in a non Western culture follows the same sequential succession of stages as described by Piaget and other investigators in the middle class Western children. Piaget's work has inspired a large number of cross-cultural studies. In fact within the last three decades or so, psychology of cognitive development bears the indelible mark of Piaget's ideas. Scholars have tried to verify his results in different socio-cultural settings, have questioned the amount of importance that he has given to environmental factors and have examined the role of cultural factors in the development of various conservation skills.

In a series of investigations, which have already been published in the form of two books, Professor S. Narayana Rao and his colleagues have studied the conservations of mass, weight and volume, as well as concepts of casuality and of life. In the present book, Professor Narayana Rao and Dr. Nalini Devi have been concerned with the development of number concept in children between 4 to 7 years. They have tried to analyze the factors of age, schooling, sex as also the influence of skill acquired concerning one kind of conservation (like mass and volume) on the ability to acquire number concepts. The work has been an exhaustive one. The present findings when viewed against the background of results obtained by Piaget and other investigators, tend to throw light on some of the vital issues regarding nature versus nurture controversy and interaction between these two factors. The authors have exhaustively dealt with their research findings and the reader going through the book gets the pleasure of first hand experience of the researcher himself. I am greatly impressed by the thoroughness with which the study has been conducted, and I am sure that the present book will be of use not only to research workers in the areas of cognitive and developmental psychology, but also to those interested in understanding the developmental pattern in children. Dr. Narayana Rao and Dr. Nalini Devi are to be congratulated for producing such an excellent monograph.

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INTRODUCTION

Professor William James (1890)[1] explained that "for the new born infant the world is a great booming buzzing confusion." Controversies regarding this description of the neonate's consciousness apart, it is true that in the beginning, the child's consciousness cannot be compared with that of an older child, not to speak of, an adolescent or an adult. The early philosophers, interested as they were, in the nature of mind, spent a good deal of their time arguing about the essential nature of "mind." Naturally their speculations were polemical and they were unwarily led into avid discussion of the dualistic or monistic points of view, entering into the domains of Ontology. The question, however, essentially remains an epistemological one. How do we know? Interest in the ways or the means of knowing became more engaging from the time of the British empiricists who held that the mind was a *tabula rasa* and that the sense impressions get inscribed on it. It is needless to enter into a discussion of the merits of empiricism and its logical extension, — solipsism.

It was towards the latter part of the 19th century that interest in the study of children's thinking drew the attention of investigators. The early investigators called the 'child biographers' employed the naturalistic method of observation and reported several interesting findings This led Stanely Hall to publish his perceptive study "the contents of children's minds" in 1891, which brought to light many of the inaccuracies, confusion and vagueness in the reports of the child biographers. It would suffice to say at this stage that scientific interest in children's mental functioning was only of a very recent origin. Thus children's mental activity was recognized to be of psychological interest only towards the end of the nineteenth century.

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[1] Principles of Psychology Vol 1. p. 488.

With the psychological interest in the study of children's understanding of the world around them, changes in the terminology became necessary. It appears more objective to describe the cognitive development than to talk of mind or mental development. The concept of mind, however significant and important it may be, could best be left to the philosophers to grapple with.

Human beings are distinguished from animals in terms of what is claimed to be the highest capacity of functioning, namely, rationality. Humans are rational while animals are not. Children, as human beings, are rational and the romanticism of the early 18th century has lent credence to fanciful notions of children's mentality. Wordsworth, the English romantic poet, sings eloquently "child is the father of man," and that the child has "the intimations of immortality in his infancy" Rousseau, the famous French philosopher and romanticist, claims that the child is all goodness incarnate but the world corrupts him as he grows up under its unwholesome influence. The romantic notions have been confined to the poetic realm. But, in day to day life, men in general usually look upon the child as a miniature adult and therefore capable of behaving and thinking like one (an adult). in the Victorian period, the life, manners and customs of people, provides ample proof of this kind of conception of children's thinking. Boys and girls were dressed in tiny adult clothes and they were expected to behave like little gentelmen and little ladies. This gave a lie to their thinking of children's mental capacities. Erroneously they tended to believe that children think in the same manner as their adult compeers.

Freud, for example, calls the child 'polymorphous perverse." This suggests that the child is being judged from adult standards, and illustrates the confusion and vagueness about such things as children's mental functions, cognitive capacities, thinking and reasoning The inauguration of experimental laboratory at Lepsizg prompted researchers to study the cognitive development in children employing experimental procedures. The work of Hull and Heidbreder illustrates this movement. The early 1920s of this century evidenced brilliant pioneering work in the realm of hildren's thinking in particular and cognitive functioning in general. It is a matter of historical interest that the experimental approach to the study of children's thinking was largely limited to the New world. It appears strange that the rest of the English speaking world lost interest in the study of children's thinking. It was only after the publication of English translations of Piaget's studies,, that the child was rediscovered.

A distinction needs to be made at this stage, for it has great significance concerning the nature of the investigations made on either side of the Atlantic It is no gainsaying that we think with the help of concepts. In the absence of concepts it is hard to think. There can be no two opinions regarding this. A distinction is made with regard to concept acquisition and concept attainment: Heidbreder's studies largely concern concept attainment Here the processes of generalization and discrimination or differentiation are explained to operate. For example, the child sees several animals cows, dogs, goats and so on, and does not distinguish one from the other. The child confuses one for the other With more experience, the child differentiates the cows from the goats. The child sees the characteristics that are common to cows which are not present in another class of animals called goats. Later on, the grown up child is able to combine both cows and goats together and use the concept of animal. This kind of conceptual behaviour is distinguished from the process of concept acquisition. Piaget's work illustrates the latter and more fundamental aspect of cognitive functioning. The method employed by Piaget in his studies with children was designated by him "methode clinique." Piaget prefers to call it a clinical method advisedly. He studies each child's thinking intensively and in depth, in contrast to the empirical method of studying a large number of children and drawing conclusions based upon them. According to Piaget in the latter method of approach "one loses the wood for the trees."

In all our thinking, we tacitly assume certain concepts like conservation, space, time, causality and the like. The philosophers were hard pressed to explain the "Why?" of such concepts Philosopher Kant explained that our thinking depends on categories of intuition and categories of thought. That is, concepts such as causality, space, time, etc., are the ways in which the mind thinks because the mind is so made. This does not help improve our understanding of how a child is able to think in terms of cause-effect relationship or in terms of space or time. Piaget has pioneered in the study of the cognitive development in children. As already been alluded to, he used the 'clinical method' by which he meant studying the child individually and in depth. He was a prolific researcher and writer. However, his pioneering work remained inaccessible and unknown to the English speaking world. In terms of the insightful and incisive thinking Piaget could perhaps be classed with Freud. Piaget distinguishes four stages in the mental development of the child. According to him these are sequential and there is an underlying logical necessity in the order of their development.

Even today some of Piaget's basic works are not available in English and we are unfortunately ignorant of his more recent contributions. Piaget has contributed to the field of cognition whereas Freud has contributed to the field of affection. Piaget explains the "How?" of human intellect and Freud attempted to explain the "Why?" of human behaviour Piaget's cognitive theory has for its central postulate motor action as source of mental operations. Thus for Piaget motor action precedes mental operations, a kind of converse of commonsense thinking. Psychology makes several such statements which are diametrically opposite to the commonsense view. A well known example is James - Lange theory of emotions.

For instance, it is commonly believed that we run or flee because we are afraid or frightened. Psychologists reverse the sequence of the things. According to them, we are frightened or afraid because we flee or run. The common man believes that dreams disturb sleep. The Freudian psychologists hold that dreams are guardians of sleep. In the same manner the common belief is that idea is the source of action. Piaget holds that action is the source of the idea. The common man believes that there is no real difference between child and adult thinking. Piaget asserts that there is a qualitative difference between them. According to him, it is not correct to believe that children's thinking is comparable to adult modes of thinking.

Piaget makes motor action the source from which all mental operations emerge. The infant has no knowledge about the environment and its capacity to deal with the environment is also limited. As the infant is driven by the urge for survival and as survival is contingent upon taking nutrition in the form of food (external objects or materials) the infant tries to put everything in the mouth. The infant does not distinguish between edible and inedible objects. Slowly the schema concerning the objects is formed. This schema is continuously being changed and modified by assimilation and accommodation of new sense experiences. Thus Piaget holds that "intellectual adaptation is the progressive differentiation and integration of inborn reflex mechanisms under the impact of experience." The infant as a result of its motor responses to stimuli has impressions which are congruent with the existing schema and therefore this impression or experience is assimilated into the schema. Such assimilable impression into schema is called *aliment*. An *aliment* is not an object. But those properties or characteristics of the object which are assimilated such that the original schema is modfied. Equally important is the need for accommodation. Accommodation and assimilation are the twin processes which cannot be separated from each other. They go together But they are not the same processes. Assimilation implies taking within for example, when a spoonful of sugar is put into a cup of water the sugar disappears, the water has qualitatively changed as a result of the assimilation of sugar. A schema as a result of assimilation undergoes a qualitative change. Accommodation is the modification of the schema, such that it does not qualitatively change but makes room for another schema For instance, the child learns that the flame of a candle burns. It does not cease to give light. The child by putting his finger in the flame or near it, experiences the burning sensation The child has now two *schemata*. In the beginning the flame was a bright and glowing thing which attracted him. Consequent to his motor action of putting his finger in close proximity to the flame he gets a new schema that the flame burns. Now the two schemata do not exist as two unrelated impressions. This is the principle of accommodation. All intellectual understanding and development is based on the twin processes of assimilation and accommodation.

Now let us outline Piaget's basic explanation of cognitive development. He distinguishes 4 stages in cognitive development, namely sensori-motor, pre-operational, concrete operational and formal operational stages He further postulates that these stages appear in a hierarchical order and that there is an invariant sequence in their appearance. This he calls the vertical *decalage*. Contrasted to this, there is a horizontal *decalage* which means that when once a function or concept is acquired it can operate under different conditions. For example, when the child learns conservation of matter he can conserve, no matter what kind or type of material is used. That is, if he can conserve solids he can also conserve liquids. He can operate with different kinds of materials plasticine, water (liquids), cubes, chips and so on.

Before we leave the discussion it would be of interest to consider the question whether Piaget is a maturationist or an environmentalist or an interactionist. The behaviourists, for example, believe that the environment fully and completely shapes the individual. By manipulating the environmental conditions one can not only manipulate individual's behaviour but also his psychological development. In contrast to this extreme form of environmentalism, we have the classical Freudian view that the individual's psychological development is based on the instinctual urges namely *eros* and *thanatos*. However, a vast majority of researchers either vocally or by implication subscribe to the interactionist point of view. Each view has its merits and limitations. Naturally the question, 'what is the point of view of Piaget?' comes to the fore. Is Piaget a maturationist or an interactionist? These issues are of great importance if, for example, we believe in maturationism, then any stimulation or activity will be fruitless unless the child has attained the necessary maturational level, readiness to profit from stimulation. Strict maturationists even go to the extent of refuting the *importauce* of the environment. In the history of Psychology the instinctive theory tended to emphasize this point of view taking a cue from the behaviour of sub-human organisms. Adherence to this point of view tends to strike a pessimistic note that, no matter what we do, the individual or the organism acts in terms of its innate drives. The environmentalists sound a very enthusiastic or optimistic note and appear to offer a positive approach. While this strikes an encouraging note we cannot be blind to what is really possible and practicable. It is said "you cannot make silk purses from sow's ears." The middle of the road point of view has always been fascinating in every discipline, be it economics, political science, sociology or psychology. However, to say that cognitive development depends on the interaction between the heredity (innate capacities) and environment (external capacities) the question still remains, "what kind of stimulations, the timing of stimulations, and the like." It is not very easy to try to fit Piaget in any one of the three points of view. Piaget, it will be of importance to note, presents a cognitive stage theory and it is a kind of explanation which implies the operation of a self-regulatory equilibration mechanism which is operative throughout the life span of the individual.

A word about development would be of help. The phenomenon of development though innocently simple at the surface has been baffling several incisive thinkers. There are three related words - development, continuity and change. The importance of these three terms cannot be dismissed as of no consequence, or discussed in isolation from one another. Understanding one term basically implies understanding of the remaining terms. For example, when an infant grows into a baby what happens? Does the infant cease, now that he is a baby? But this question appears rediculous. We say there is a continuity between the two. But what of the disappearance of so many things characteristic of the infant in the baby. Similarly several aspects that a baby does were not present in the infant. How does it explain continuity? Perhaps we see quite an amount of this continuity between the two, - infancy and childhood. This holds good for any given stages. It is therefore difficult to define development avoiding continuity - discontinuity confusion. The term development is variously used. Atleast four different meanings of it could be discerned.

Children differ from adults with regard to their ways of thinking. The young child knows less than what he will know later when he grows up. The child's experiences are not related to one another and are organized in a manner that is not similar to what happens in the adult mind. The children's thinking not only differs quantitatively but also qualitatively from the adult modes of thinking Thus cognitive development is a process of restructuring of knowledge and skills. This suggests that there are atleast two basic assumptions, viz , 1. that the individual's behaviour is based on cognition which is the process of knowing about the situation in which the behaviour occurs and not on the situation itself. The individual thinks about and assesses the situation before he responds to it; and 2. That a person's way of thinking cannot be explained simply on the basis of associations between his past experiences. The child's mental activity is influenced by the maturational as well as environmental factors.

When we examine the responses of children of different age levels to questions such as causality or mass, and the like, they seem to point to the stages of (cognitive) development; Whether there are any overall stages in development and whether the different stages found in more limited areas, contain any elements in common? Piaget tried to detect broad periods in the development with characteristics that can be applied in a general manner to all events of these periods.

Piaget postulated four major periods in the cognitive development of children. First is the sensori - motor period, which is evident even before the acquisition of language. This period in the words of Piaget is characterised by sensori–motor intelligence, which results in a certain number of performances concerning spatial relationships, notion of permanance of objects, and the like. After the sensori–motor period, follows another period which starts with the symbolic or semiotic function. Piaget called this period pre–operational thought, since the child is now capable of showing representational thought by using symbolic function. However, the child cannot perform operations in Piagetian sense which means that the operations are not internalised actions which are reversible. They cannot be performed in opposite directions. The operations are co-ordinated into overall structures which suggest the implied feeling of intrinsic necessity. The next stage observed is around the age of seven or eight years and exhibits inception of operations. At the outset the operations are concrete. i.e., they are based on objects and manipulations of them. They remain concrete until about eleven or twelve years of age. Approximately at this age, the fourth major period begins. It is characterised by formal operations, i.e., propositional operations. This means that the operations are no longer applied solely to the manipulation of concrete objects, but cover hypotheses and propositions that the child can use as abstract hypotheses from which he can reach deductions by formal or logical means. With further development, the more elementary structures become incorporated into higher level structures. A significant question could be posed at this point : Do these structures really exist in the mind of the subjects studied or are they merely an invention of the psychologist ? The subject is not aware of his cognitive structures. He acts, he operates, and he behaves. From his behaviour we deduct structures. The structures are not conscious. But he uses them, so the questton : Do they really exist in the subject's mind or are we inventing them ? Are they the artifacts that we recourse to ?

In seriation, for example, a stick is longer than the ones that preceded it and shorter than the ones that follow it. This is a good example of a structure (Piaget calls this capacity of the child to grasp the dual nature or reversibility of the idea–cognitive structure). Logically seriation is a chaining of asymmetrical connections and transitive relations. A is longer than B, B is longer than C, so A is longer than C. This is transitivity relationship. Children who use deductive method find transitivity as evident. It is not only evident but it is necessary. Until this point (development of structure), a certain occurance was either absent or simply probable. Now it becomes necessary. From the psychological point of view, this notion of necessity is the problem of overall structure. According to Piaget, the feeling of necessity comes from the closure or completion of a structure. Hume explains such things as causation as illusions or as matters of habit.

The question of passage from one stage to the next is of vital importance. What mechanisms are responsible for this passage? Three models are usually employed to explain passage from one stage to the next. According to them: 1. they result from environmental pressures, i.e., experience, in this case the succession of the stages would no longer be necessary; 2. the stages may be internally determined, i.e., they are pre-programmed. This ts to return to the concept of innate ideas; and 3. the overall structures become necessary with development but are not so at the beginning

At the sensori-motor level we find composite actions which are performed in a step by step or contiguous manner, since the child is not capable of representation (symbolic) which would allow for more complex relationships. The child's actions comprise actions which are chained to one another but which nevertheless form some kind of structure. At the level of pre-operational thought other overall structures are evident but they are yet to reach reversibility. At the concrete operational stage are found great many overall structures which are richer than the ones found at the pre-operational stage At this level quantification becomes possible. Finally, the level of formal operations synthesizes all the previous structures. The stages are characterised by successive structures which do not replace each other but which are integrated into one another. The simplest ones become incorporated into more complex ones later. The structures have a biological meaning in the sense that the order of the stages is constant and sequential Each stage is necessary for the following one. If it were not so, there can be no question of stages The exact chronological age at which different children reach the stages may vary. In some social environments the stages are accelerated, in others they are more or less systematically retarded This differential development shows that stages are not purely a question of the maturation of the nervous system, but are dependent upon interaction with the social environment and with experience in general. The order however, remains canstant.

Another question often raised is: Can the development bespeeded up? There is an optimum level of speeding for each species of organisms. Passage from one stage to the next happens much earlier in one species but is quite delayed in another. The question of passage from one stage to the next is sought to be explained employing three different models, viz., recognitive memory, evocative memory or reconstructive memory. First it could be argued that the successive acquisitions which characterise the stages or acquisitions which are due to environmental pressures to experience, or to more or less random encounters with certain aspects of the daily social and physical environment. In this case succession of stages is no longer necessary. It might be a regulative succession with some regularities more or less emphasized or attenuated depending on the environment. But there would be no necessary succession. The second possibility would be that the stages are internally determined. The succession of stages would be somehow performed in the hereditary equipment of each individual. The third approach is most apt to Piagetian explanation. According to Piaget the stages result in a certain number of overall structures which become necessary with development but are not so at the beginning of life. For example, formal structures become necessary once the child possesses concrete operations. As soon as he can perform the concrete operations, sooner or later, he will begin to coordinate reversibility by inversion with reversibility by reciprocity and hence construct the group of form transformations. Similarly, once he is able to manipulate the classifications, sooner or later he will construct a classification of all the classifications and thus be able to produce the 'combinational' which is a necessary form of formal thought.

In sum, the stages are characterised by overall structures which become necessary but which are not so initially. Formal structures become necessary when the concrete structures are complete, concrete structures become necessary when the structures of identity of function, etc., are complete, and these in turn become necessary when the sensori-motor functions are complete. But nothing is given in an *a priori* or innate fashion, nothing is performed or pre-determined in the activity of the baby.

The role of experience in cognitive development is crucial. Piaget employs the accommodation - assimilation model which constantly modifies the *schema* or *schemata*. When we say there has been development, we simply mean that the child has progressed in A, B. C, etc. What do we mean, when we say that he has progressed in A, B, C, etc ? We mean that he has developed or matured. We still have not identified the mechanism by which the change has been induced. We have merely constructed something of a circular definition

According to Piagetian theory there are five primary principles that describe development. They are :

1. Learning is subordinated to development an not *vice versa.*

2. Learning is associated with developmental stages and these occur in an invariant succession, stage B must always follow stage A and not *vice versa.*

3. Only one type of learning can be accelerated through the use of external reinforcement. The logical structure is not the result of physical experience. It cannot be obtained by external reinforcement. The logical structure is reached only through internal equilibration, by self regulation.

4. The only way to teach logical structures is through the process of internal equilibration and self-regulation. Conversely, if we observe a child who has acquired logical structures in conneetion with a specific test we could conclude that the child has acquired his skill through an internal process of self-regulation.

5. The structures that are induced through equilibration last a life time.

REVIEW OF RELATED RESEARCH

In contrast to the 'age bound' intelligence testing work. efforts to understand the processes involved in cognitive development emerged as an alternate mode of approach. Plausible explanations are sought for explaining the changes in the modes of thinking of the child as he grows.

The term thinking, according to Lovell (1968) means a flow of connected ideas or mental actions directed towards some end. In explaining cognitive development, Bruner (1960) suggests that the child first gathers information through action in its earliest months and years of life, later through imagery, and finally through language Piaget's conceptual framework provides more information than Bruner's in understanding the problem of intellectual development.

Piaget (1952) studied the fundamental aspects of numerical operations which include child's understanding of ordination and cardination, child's grasp of the additive and multiplicative properties of numbers, the genesis of mathematical notions related to the above, e.g., the operation of one-to-one correspondence. According to Piaget, number concepts develop in an invariant sequence. He further maintains that number is the fusion of classes and relations which develop at the same time.

Much of the early work, in the area of number concepts, centered round the study of counting and arithmetic achievement. Beckman (1924) and Descoedres (1921) extensively studied 2 to 6 year old children on the ability to estimate number accurately. Baldwin and Stecher (1925) employing Descoedres' procedures studied an American sample of 3 to 5 year old children. Beckman employed 4 different tests to study children's ability to estimate number. The results generally showed that children can produce small numbers like 2, 3, 4 at about 2 to 3 years of age. Only children who are 5 years old or more were able to produce larger numbers. Buckingham and Maclatchy (1930) presented children who had no previous instruction in arithmetic with estimation tasks Only 42, 45, 46, 52 and 63 percent of the children were able to estimate the numbers 10 8, 7, 6 and 5, correctly on all the 3 trials Beckman's study supported the conclusion that children estimated a number by counting before they could produce the same number Clark (1950) found that the use of simple numerical terms in a conversational way often occurred without comprehension of their meaning among children. With increasing age children's ability to handle concepts of number, increased in complexity

More recently, Beckwith and Restle (1966) studied the process of enumeration and concluded that it is fundamental to arithmetic and that in counting, the set of objects is grouped perceptually and this grouping served as a basis for counting.

Studying the acquisition of concepts, Lovell (1966) found that the notional concepts develop in an informal-formal sequence and that concept of number is learned informally. Suppes (1966) suggested that acquisition of simple, mathematical concepts was closely approximated by an all or none assumption than by any simple incremental assumption.

Gelman (1972a) in his article, "The nature and development of early number concepts", distinguished between the 'estimators' and the 'operators'. According to him persons who employ the cognitive processes to determine some quantity, such as the numerosity, of a set of objects, could be called estimators; and 'operators' as those, who use the cognitive processes by which the quantity is transformed in various ways. According to Gelman, estimation involves lower level of processing than making operations. He emphasizes therefore, that a child cannot be said to have a concept of number until he passes the 'operator' task (operator task means conservation ability) conversely a child without conservation ability cannot be said to have a number concept.

Thus much of the work in the area of number concepts was concerned with 'estimators'. Piaget was perhaps one of the first few investigators who was interested in investigating 'operators'.

Unlike Piaget's other works on language and thinking, the study of the development of number concept in children has not produced, "very great acclaim or criticism.... nor has it stimulated much research by independent investigators", (Dodwell, 1961). It is only in the last two decades that this area has come to be recognized as an important area of research.

There is a suggestion that children will be able to perform simple arithmetical problems before they can solve the problem of conservation. Studies tend to suggest that children who failed to conserve benefit from training in performing simple arithmetical operations (Smedslund, 1961; 1966b, Winer. 1968). However, Beilin (1971), Rao (1974) found no evidence of inducing conservation, by training on related tasks.

Another closely related aspect studied was the investigation of normative steps in the child's acquisition of number concepts. Munn (1938) found average 4 year old children to have acquired the capacity to count 2 and 3 at 5 years, and 9 at 7 years According to Russell (1936) the child's first impression of number is manyness The first differentiation is of more and less. For the young child "many" would mean beyond his power to count. Others like Giltay's study (1936) reported the age range at which a given number concept first appears. Children's knowledge of intermediate number concepts also received some attention Grisby (1932); Pratt (1948); Brotherton, Read and Pratt (1948) were some of the studies. Gelman (1972b) believes that young children can abstract number from small arrays of objects. They can infer change of number from 2 to 3 or vice versa, must involve the addition or subtraction of an item.

From his studies of children, Piaget (1952) asserts that conservation is a necessary condition for all rational activity. A set or collection is conceivable only if it remains invariant despite changes occurring in the shape or the size. Thus a number is only intelligible if it remains identical with itself, irrespective of the manner of distribution of the units of which it is composed.

Following Piaget's thought provoking investigations in this area, several empirical researches were made. The work of Dodwell (1960); Elkind (1961); and Wohlwill (1961) support the notion that the attainment of level of conservation marks a clearly defined stage in the formation of number concept. Wohlwill and Lowe's (1962) investigation highlights the fact that considerable gap separating the ability to enumerate by counting from a true understanding of the number concept as it is reflected in the principle of conservation. Halford and Fullerton (1970) used a discrimination task to induce the acquisition of conservation of number. They found that 8 out of 12 experimental subjects attained conservation.

Hamel and Ricksen (1973) presented different kinds of verbal rule instructions in conservation of discontinuous and continuous quantity. The training procedures resulted in non-specific transfer to conservation of number, substance and weight. The group receiving verbal rule instruction profited more.

Miller, Heldmeyer and Miller (1975) attempted to identify conditions that facilitate conservation. The results obtained showed that some perceptual supports facilitate conservation.

According to Piaget prior understanding of ordination and cardination are equally necessary for the development of a natural number concept (number conservation). Brainerd and Fraser (1975) in their study found that the sequence of develop ment of number concepts in 5 to 7 year old children was ordination, natural number and cardination In his study on number conservation, Barry (1978) found that all the subjects conformed to response patterns compatible with cognitive developmental stage theory.

Mehler and Bever (1967) found that very young children show number conservation which is lost by them between the 3 to 4½ year period Using similar methodology as used by Mehler andBever, Rothenberg and Courtney (1968) reported results whichwere not in agreement with those reported by Mehler and Bever.

Zimiles (1963) analysed the transition from the first to the second stage of conservation of number. He concluded that this transition required assimilation of counting and other number skills which cannot be imparted in a short-term training procedure Gottfried's (1969) study indicated that number conservation performance of his subjects was clearly superior to length conservation. Similarly Brainerd (1972) found number conservation to appear developmentally earlier than liquid quantity conservation.

A number of investigators Piaget (1921); Welch and Long (1940) ; Richard, Schneider and Rapaport (1944); Perugia (1950) and Hoffman (1955) stress the importance of age in the development of concepts. Sigel (1953) in another study found that as the age increased from 7 to 9 to 11 years the use of conceptual grouping also increased. Annett (1959) studied 303 children in the age range 5 through 11 years Obtained results showed that the errors were systematic rather than random till the time of the appearance of correct responses Other studies, like those of Halasa (1967) showed that age was an important variable in conservation performance. Estes and Combs (1966) found children's responses to numerosity and reported that older children performed better than the younger ones. Calhoun (1971) also found age X response mode interaction to be more significant. Nelson (1974) attempted to study the age factor in relation to certain cognitive operations involved in conservation of number, mass and continuous quantity. The results obtained showed that 84 percent in the 5 year old group and 94 per cent in the 6 year old group understood equivalence and reversibility involved in conservation of number. Simon and Ward (1975) investigated the relationship between the ability to derive concepts from various visual figures and chronological age (7 to 11 years). They found significant correlation between total conceptual score and chronological age. Saxe (1979) investigated the developmental relations between notational counting and number conservation. Results showed that children developed quantitative counting strategies before they developed number conservation concepts.

The results of Peters (1969) and Reimer (1968) indirectly suggest that variables such as intelligence, social status, language comprehension, etc., affect number conservation.

The importance of cultural background in number conservation was examined by a number of investigators although Piaget (1964) asserts that in cognitive development environmental factors have a relatively minor role. Harrower (1934) compared lower class children using stories in order to examine the sequence of development postulated by Piaget He found that the order of development was the same as that given by Piaget (1932) in the lower class children. In another study Harrower and Semin (1952) found that the upper class children developed concepts earlier than the lower class children. After analyzing the performance of upper and lower class sixth graders on conceptual items on intelligence tests Siller (1957) concluded that upper class children performed better. In contrast, several studies reported by Gibb and Van Engen (1959) showed that there was a low relation between socio-economic factors and concept scores.

The studies of Delemos (1969); Tuddenham (1969); Vernon (1965); Reddy (1970) showed that even on Piaget's tasks there were significant cultural influences which support the hypothesis of differential performance across racial and social class groups. Studying the influence of socio-economic variables, Almy (1966) investigated conservation in lower middle class children. However the study lacked proper use of experimental techniques. Skypek (1967) studied the development of cardinal number conservation concepts among children from different socio-economic environments. The obtained results showed that the relation of socio-economic status to concept development to be significant with a bias towards middle class children. Among the low status subjects there was discernible retardation in the development of number conservation. Kaplan (1968) reported that disadvantaged children were handicapped in acquiring number conservation Gil Gaudia (1972) found significant differences between the different racial groups. Haney and Hooper (1973) found that there were no significant differences with regard to socio-economic status levels for any of the Piagetian tasks. Baker (1973) studied the conceptual development of disadvantaged and non-disadvantaged children. The results showed that disadvantaged children did not perform as well on the tests employed as the non-disadvantaged children.

According to Piaget (1952) the ability to understand classes and relations is basic to the development of spatial, geometrical, numerical, etc., concepts. Employing a modified form of his "clinical" method Piaget presented an airy of objects to children in the age range 2 to 11 years for classification. From his observations Piaget concluded that there were 3 stages of development, the first two called preoperational, and the last, the stage of concrete operations.

Since Piaget's work on the number concepts of children was an epoch making one, several studies were made by investigators to replicate and/or to check the Piagetian findings. Before we refer to these studies a few studies in the normal Piagetian tradition could be mentioned in passing. Long and Welch (1941) investigated the development of the ability to discriminate marbles and match numbers using 135 school children. The results showed that performance of subjects improved with increase in age of subjects.

Piaget and Szeminska (1941) found that number concept evolves stage by stage in complete correspondence with the gradual elaboration of the systems of inclusion (hierarchy of logical classes) and of asymetric relations (quantitative series). The only study which found no evidence of Piaget's theory of development of stages or age levels in the acquisition of mathematical and logical concepts is that of Estes (1956). Gast (1957) found that the numerical concept for objects develop in three stages, but only in the last of these, occurring after the age of 6.6

can one speak of an operational and abstract concept of number. The development of numerical concepts is directly dependent on the total mental development of the individual.

Hyde (1959) administered a large battery of Piaget's number and quantity tasks to groups of European, Arab, Indian and Somali school children between 6–8 years of age. The results showed that: 1) the same general type of responses to number problems as Piaget had found in Swiss children were shown by the experimental subjects; 2) the observed developmental changes and responses largely confirmed Piaget's findings; and 3) there were some significant racial differences. Dodwell (1960) found all the three stages in the development of number conservation. He reported that a child who gave concrete operational responses to one problem could also occasionally give pre-operational responses to another problem. Mannix's (1960) results corroborated Dodwell's finding that Piaget's description of the major types of responses children gave to his number tasks was largely correct. Wohlwill (1960) studied the developmental sequence in the formation of number concept in 4–7 year children. The obtained results were largely in conformity with Piagetian findings: Elkind (1961) studied conservation of number in continuous and discontinuous quantity in 4–7 year childern, The results showed that: 1) all types of conservation are age dependent as reported by Piaget, 2) conservation of continuous quantity is more difficult to acquire, i e., it is acquired at a little higher age, 3) there was positive correlation between ability and conservation scores. Hood (1962) studied three groups 1) normal children, 2) mentally retarded children and 3) adults. He found that pre-number concepts develop as the child grows older. Normal children were able to think operationally in certain number concepts while the retarded children of corresponding age levels failed to do so. In another study Elkind (1964) studied the 3 operations namely: discrimination, seriation and numeration employing one–, two–, and three–dimensional materials. Results indicated regular increase with age in the child's ability and showed that dimensionality of materials affected the performance significantly, but not the sequence of tasks. Results indicated regular increase with age in the child's ability and showed that dimensionality of materials affected the performance significantly, but not the sequence of discrimination, seriation, and numeration tasks. Iigima (1966) observed that in comparing the number of two aggregates subjects were influenced by the perceptual configuration. The magnitude of numbers is scalable according to the order of difficulty and the younger group did not understand one–one correspondence. The developmental sequences of number concept appears to cover the following periods : 1) numerical operations not understood at all, 2) to lower numbers not understood, 3) verbal levels understood, 4) ability to abstract numerical dimension 5) understanding of the ordinal number and 6) conservation concept. Miller (1967) reported findings conforming the sequence of development of the concept as described by Piaget. Swayze (1967) reported results that confirmed the general movement from perceptual to conceptual thought as described by Piaget. Iigima (1967) studied 1) comparative judgment of the number of elements in a visual display through manipulation of density and arrangement, 2) understanding of the concept of number change (addition and subtraction) and 3) the role of verbal labels in the estimation of element magnitude through variation in the stimulus pattern Results indicated that subjects did not fully understand number construction. The role of verbal labels in judgment and transformation of elements was significant. Although most subjects were able to abstract the number independent of stimulus cues they did not understand additive composition and it was concluded that they were in a transitional stage between the 4th and 5th phases of development (subjects were seventy, 6 year old children). Murray and Youniss (1968) reported developmental differences among 3 age levels 5 to 7 in understanding transitive inference and showing success on seriation. Carr (1971) examined the extent to which an academic pre-school programme facilitated the development of number concepts in children. Four Piaget type tests concerning conservation of number, discrimination, seriation, and numeration were administered to children. The results showed that age was an important variable accounting for the development of number concept in children. Training did not have significant influence. Children between 3 to 4 years appeared to be too young to benefit from training. Arithmetic instruction was not affective or meaningful until the child reached a certain level in his cognitive development. Siegel (1972) investigated the problem of development of concept of seriation. The results showed that it was easier to identify and positions of the series than the mid positions. Youssef and Guardo (1972) studied additive composition of classes with young children. The results supported Piaget's contention that pre-operational children respond in terms of perceptual cues. Siegel, McCake, Brand and Matthews (1978) investigated the problem ; "evidence for the understanding of class inclusion in pre-school children : linguistic factors and training effects". They concluded that the pre-school children's failure to reason logically might be owing to the immature language competence and not due to the lack of reasoning skills. Smith (1979) tested the young children's ability to evaluate the relationship between concepts as one of inclusion. The results indicated that majority of children could evaluate inclusion relations. Brainerd (1977) studied the effects of spatial cues on children's cardinal number judgments. Results revealed that, in addition to the effects of relative length and relative density cues, children's cardinal judgments were influenced by extreme crowding. Russac (1978) investigated the relationship between the two strategies of cardinal number, i.e., correspondence and counting. The results showed that children were able to apply a counting strategy to comparisons of small equivalent and non-equivalent collections prior to making the same comparisons by correspondence.

Inhelder and Piaget (1964) found three stages in the development of multiple seriation. Stage I – no seriation; Stage II – seriation along one of the two dimensions, Stage III – multiple seriation. They believe that the coordination of the two homogeneous seriations lead to the 3rd stage. Mackay, Fraser and Ross (1970) suggested the possibility of an intermediate stage between 2nd and 3rd stages, but their study failed to show such a stage. Angeler and Kuhn (1976) found the intermediate stage in the development of multiple seriation.

APRAISAL

From our brief review of some of the relevant studies the following stand out as significant : a) Piaget minimizes the improtance of environmental factors as positively influencing the cognitive development in children. Traditional American thinking has long stressed the significance of learning. Development of concepts involves the process of unfoldment of thinking which is largely due to genetic factors, or nature. Concept attainment on the other hand, appears to be instigated by experience, i.e., nurture b) The second issue is to examine the role of cultural factors in cognitive development. Piaget (1964) suggests that, in cognitive development, environmental factors play relatively a minor role, c) The importance of factors such as mental ability, socio-economic status and the like, in cognitive development have not been studied systematically.

Piaget's work on number development in children is considered to be significantly more soundly carried out than his other studies in that there was greater amount of experimental rigour. Notwithstanding this, comparatively fewer studies have been reported in this area. In India there is a glaring paucity in studies concerning Piaget's work in general and number development in particular.

Piaget described a number of stages in the development of the number concept. According to him, about the sixth year, children display a spontaneous interest in numbers and are able to count Yet, Piaget holds that the children have only a vague notion of what the concept of 'number' is.

THEME OF THE PRESENT INVESTIGATION

Problem

According to Piaget number concepts in children develop in an invariant sequence. He asserts that conceptualizing ability follows from the internalization of the child's grouping, ordering and counting actions which are supposed to give rise to class, relation and number. Piaget's assertion of invariance was corroborated by some studies, e.g., Elkind's (1964). On the other hand, the suggestion that these sequential stages as described by Piaget, need not appear necessarily is made by studies such as those of Dodwell (1960, 61, 62). It appears that there is a need to re-examine this issue. Further the importance of factors such as educationl background, urban - rural setting, socio-economic status, mental ability of the child, etc , cannot be overemphasized. It would be of interest to know why and how school experiences influence the acquisition of number concepts. If concept formation were the outgrowth of maturational process underlying mental development, the differential experiences from schooling or absence of schooling may not bear any significant relation to the nature of concepts acquired. If we grant that learning and experience have a significant role in mental development, naturally concept development would significantly be influenced by the learning opportunities, quality and richness of the learning experiences, etc. Thus schooling would be expected to play a very fundamental part in the mental development of children in general and their cognitive development in particular.

Piaget's system depended on a logico-mathematical system integral to the scientific thought pattern of Western cultures. Greenfield (1966) reported some cultural differences when this system was applied to non-western cultures. In India precious little work appears to have been done on this important area of the development of the number concept in children.

It is assumed that intelligence or mental ability and concept acquisition would be related to some extent. But no specific attempt appears to have been made to investigate this. Generally investigations attempted only to relate variables such as sex, age etc., to concept development.

In the light of the foregoing, the present study was designed to examine the following :

1. Would the age differences in children affect their discrimination, seriation and numeration performance?
2. Do the operations of discrimination, seriation and numeration follow a fixed sequence?
3. Would the discriminating/seriating/numerating ability be affected by perceptual cues or is the ability a resultant of development of mental structures independent of experience?
4. Would school learning help acquisition of discriminating/seriating/numerating ability independent of growth?
5. Would there be differences of a significant nature with regard to number concepts acquired by boys and girls?
6. a) Would conservation of number affect the development of discrimination/seriation/numeration ability?
   b) Would the child s ability to numerate (not counting) affect the development of discrimination/seriation/numeration ability?
7. Would discriminating/seriating/numerating ability be influenced by the level of mental ability, i.e., would the level of mental ability significantly affect the discriminating/seriating/numerating ability?

In the light of Piaget's results, and results of investigations reviewed here, the following hypotheses were formulated for examination :

1. Age differences would be significantly related to the differences in the development of discrimination/seriation/numeration ability.
2. A distinct stage sequence would be found in the development of discrimination, seriation and numeration.
3. The operations of discrimination, seriation and numeration would be affected by the perceptual cues like dimensionality.
4. The experience of school learning or absence of the experience of school learning would be significantly related to the differences in discrimination, seriation and numeration performance.

5. There would be sex differences with regard to the acquisition of number concepts by the subjects.
6. a) The development of discrimination/seriation/numeration ability would be affected by the ability to conserve number.
   b) The development of discrimination/seriation/numeration ability would be affected by the child's ability to numerate.
7. The level of mental ability would be significantly related to discrimination, seriation and numeration abilities.

VARIABLES

In the study of cognitive development, the importance of continual interaction between the individual and the environment cannot be over-emphasized. Factors such as age, sex, mental ability, differential cultural and educational backgrounds perhaps contribute to significant variations in the acquisition of concepts. Though, the results reported by Piaget have been confirmed by other investigators, his interpretations of them have been questioned by several researchers. Investigators sought to examine the extent to which the results obtained by Piaget with middle class Western European children are generalisable to children of other races, cultures and geographical areas. Similar results if obtained, pose no problem, but if differences are found, it would not be easy to account for the cause(s) of the differences. The present investigation considered the following variables in their relation to the acquisition of number concepts.

SCHOOLING/NO SCHOOLING :

Practically no information based on systematic studies is available regarding the effect of schooling on the nature of concepts acquired. Greenfield (1966) worked in Senegal, French Africa, with Moslem Woiof children. The subjects were grouped according to residence and school attended: urban-school, bush-school, and bush-unschooled. They were tested in their native language on liquid conservation task. The results showed that no more than 50 per cent of the unschooled bush children attained conservation by the age of 11 to 13 years. By the same age level urban (Dakar) and bush school children showed 100 per cent conservation. Goodnow (1969) reviewing several cross-cultural studies concluded : (a) Some tasks are more vulnerable than others to departures from urban, western schooling. The most hardy of the tasks appears to be the conservation of number, (b) The tasks that are less vulnerable to cultural differences may be those for which the child has action models, (c) "The critical skill may be versatility in the use of different sources of information and different models." Investigations undertaken elsewhere may not be quite meaningful in this context of differential socio-economic, educational and cultural backgrounds that prevail in the Indian situation. Hence the present investigation attempted to study the differences, if any, between the school going and the non-school going children in the development of number concepts.

In this study pupils from Municipal and Private schools were employed as subjects.

AGE :

In the acquisition of concepts, age has a pre-eminent role. Several investigators are interested in testing Piaget's interpretation of his findings, namely, that the age differences in performance are attributable to cognitive structures or mental operations. According to Piaget numerical operations develop through the ages 4 to 7 years. Therefore, children in the age group 4–7 years were chosen for this investigation. The children were divided into 4 age levels from 4 through 7 by one year intervals.

SEX :

The reason for the observed sex differences (in some studies) in the acquisition of concepts may be owing to the existence of differences in the specific nature of the task and also the differential social standards for the two sexes. As it is not known whether sex differences affect cognitive development in general and number development in particular, this study examined the differences between boys and girls in the attainment of number concepts.

MENTAL ABILITY

Studies concerning relationship between mental ability and concept formation yielded equivocal results. Beard (1960) using a concept test, based in part upon Piaget type tests, obtained a correlation of 0 38 between performance and Stanford-Binet M.A. Elkind (1961) quantified several of Piaget's conservation tests (number, continuous and discontinuous quantity) and obtained a correlation of 0.43 with full-scale I.Q. on the WISC. Using a Piagetian task of logical classification Dodwell (1961) obtained a correlation of 0.34 with I.Q. Hood (1962) found that children with M.A. of less than 5 years almost never showed conservation but children with M.A. of eight or nine years were almost always conservers. Goldschimid (1967) also reported similar results. The findings reveal that Piagetian tests and I.Q. tests onerlap to a certain extent but do not tap the same range of mental abilities. Kuhn (1976) obtained a high correlation between mental age and Piaget's stage of concrete operations among 52 middle class 6-8 years old Ss. The correlation between mental age and progression toward Piaget's stage of formal operations among 56 middle class 10-12 years old was found to be non-significant. Studies regarding mental ability and concept development were made using largely verbal type of tests. In this study the relation of mental ability to concept development was examined using a non-verbal type of instrument such that it could help clear equivocality of the relation between mental ability and concept development to some extent.

In the present study the relationship between mental ability and development of number concepts was examined. As young children have obvious limitations with language and speed, care was taken to avoid these difficulties by using draw-a-man test to assess the level of mental ability of children.

SUBJECTS

The population from which the subjects for the present investigation were drawn comprised children in the age group of 4+ through 7+ years from Tirupati. The sample of subjects for the investigation was obtained by a three-stage procedure. First, 10 different areas (10 localities of the town) were randomly chosen. Second, children from the age range 6 to 7 years attending schools were listed separately sex-wise. Third, from the lists as above, 36 boys and 36 girls were selected at random from each age level. In the investigation proper, 25 per cent more than the number of subjects (Ss) required at each age level were studied so as to obviate any loss of Ss during the investigation proper. Children for the 4 and 5 year schooling groups were selected from private schools and the rest from Municipal elementary schools.

The subjects for the non-school going group were obtained by first preparing a Census from 10 different localities of the town of the children not attending school. (Schooling is supposed to be compulsory for children in the age group 6 to 11 years. However, owing to various reasons, a large number of children do not attend school, the enforcement of the concerned legislation is obviously slack) The children are listed sex-wise at each age level 4 through 7 and the Ss for the investigation proper were drawn from these lists, As a precautionary measure to over come loss of subjects, over-sampling to the extent of 50 per cent was resorted to as in the case of school going subjects. A larger persentage of Ss had to be sampled as the loss of Ss in the non-School going group was found to be more pronounced.

TABLE 1 — Distribution of Subjects, Age, Sex and Schooling-wise in the Study

	BOYS			GIRLS			
Age in years	School gonig	Non-School going	Total	School going	Non-School going	Total	Grand Total
4	36	36	72	36	36	72	144
5	36	36	72	36	36	72	144
6	36	36	72	36	36	72	144
7	36	36	72	36	36	72	144
	144	144	288	144	144	188	576

MATERIALS

The materials used in this investigation were (a) three-dimensional (b) two-dimensional, (c) uni-dimensional. All materials were made of wood and they were in two sets. The smaller set was painted orange and the larger set was painted red. The materials were size graded. In the first set the smallest was a ¾″ cube and the largest was a 4¾″ cube. The smallest three dimensional block in the second set was a 1″ cube and the largest was a 5″ cube. In each series there were nine blocks. For the two dimensional materials, wooden slats were used. There were 9 slats in each series. All the slats were 1½″ in width and 1/3″ in thickness. The smallest slat was 1½″ long. The size was increased by ½″ such that the largest was 5½″ long. For one dimensional material wooden sticks of 1/3″ diameter were used. The smallest stick was 1″ long and it was increased by ½″ in length. The longest stick was 5″. The second set of sticks commenced with 1¾″ and incresed by ½″. The length of the sticks was same as that of the slats and the two series were painted similarly.

TESTS

Discrimination Tasks : For this test, the subject was presented with four problems with the blocks, four with the slats, and four with the sticks. Experimenter (E) placed a set of nine blocks/slats/sticks, as the case may be, in disarry upon the table in front of the subject(S) E said : "Can you find me the smallest (block/slat/stick)? Show me the smallest" (Item 1), E: Can you find the largest? Show me the largest (Item 2). Now hiding the eyes of the subject, E disguised the smallest element such that it appeared larger. If it was a block, it was placed in front of other blocks. If it was a slat or stick, it was placed such that its upper edge protruded beyond that of the surrounding elements. Uncovering the eyes of S, E asks : "Find the smallest now! Show me the smallest" (Item 3). When the S responds, S was asked to hide his eyes again, and when the S did so, E camouflaged the largest element. If it was a block, it was hidden behing the other blocks, if it was a slat or stick, it was so placed that an element on one side of it protruded above it and an element on the other side protruded below it. The S was asked to see and E asked the question : "Show me the largest now, find the largest' (Item 4). The same procedure was followed with the other set of materials. For each correct response a credit of two points was given making the possible score of 8 with any one material Thus, the maximum possible score for one set (small or large) having three types of materials was 4 points.

Sertation Tasks: A set of nine elements was placed in disarry on the table. Experimenter (E) asked, "Can you make a stairway with these? Now see how I make". Then the experimenter made a statirway. E disarranged the elements and said: "Now, make the stairway just as I did". If the S had any difficulty only 4 elements were given and he was asked to seriate (Item 1). Ss who failed to seriate four elements were not tested further. If S succeeded, he/she was given 7 elements to seriate (Item 2). Testing was discontinued if the S failed with 7 elements. If S succeeded he/she was given 9 elements to seriate (Item 3). Ss who failed to seriate were not tested further. To test those Ss who initially, or eventually succeeded to seriate 9 elements, E removed 5 elements from the stairway and picked 5 elements at random from the second set. Then E said: "I have some more that also go in the stairway; can you put them where they belong? (Item 4). If the subject did not get the idea, E demonstrated with one element and disturbed them afterwards. Each correct seriation item was given a score of 2 and if the child intially succeeded in seriating all the 9 elements he was given 6 points and 2 points for correctly doing item 4. The total score subject could possibly make was 8 points with any one type of material. Subjects who succeeded eventually were given 1 point each for seriating problems four and seven elements (item 1&2), 2 points, for seriating nine (Item 3) and 2 points for (Item 4). The possible score was 6 points for those Ss who have succeeded eventually, on any one material

Numeration Tasks: Nine elements were arranged into a stairway. E asked the subject to count the number of stairs (Item 1.) Then the experimenter pointing to the first stair asked the S: "How many stairs does the dolly have to climb to get on this stair? When the S grasped the idea, E pointed to the second, third......ninth stair in succession. asking how many stairs the doll had to climb to reach the stair concerned (Item 2). E pointed to the 4th stair and asked: How many stairs must the dolly climb to reach this stair? When the child answered, E pointed to 7th stair and repeated the question (Item 3). Next E mixed all the elements and said: "If the stairway was together like it was before, how many stairs would the dolly have to climb to research this stair (4th) and this one (7th), (Item 4). For each correct response to the item S was given 2 points each. If the S failed to respond to item 3 with 7 elements and item 4 with 7 elements but could do with 4 elements only in either case only 1 point instead of 2 for each item was given. The possible score was 8 points with any one type of material.

EXPERIMENTAL DESIGN

The study, involves 5 independent variables, viz., sex, ages schooling, tests (operations), and materials The design employed was schooling (2) × operations (3) X materials (3) × age (4) levels.

The design of the study was a factorial design. This design was employed for the reason that it has a number of advantages. All the number of observations are taken into account though each treatment group may consist of only a few observations (Ss). Further, in the factorial experiment we have information about the main effects as well as the interaction effects. If the interaction effects are found to be non-significant we would have evidence that the main factors operate independently. When the interaction effects are found significant the nature of interaction could be investigated into.

The total number of subjects employed in the study were 576 comprising equal number of boys and girls. Analysis was made independently for boys and girls. subjects were randomly assigned to the experimental conditions of testing

The analysis of the data was made separately for boys and girls For each group the design was schooling/no-schooling (2) X tests (3) X materials (3) and X age (4) levels.

At each age level there were 144 subjects divided into 2 equal groups of boys and girls. The boys and the girls were further divided into equal groups of school going and non-school going children. Three operations or tests namely, discrimination (D), seriation (S) and numeration (N) were studied. Subjects were presented with the operations in one of the six possible orders. The operations were tested using 3 different types of materials which could be presented in 6 possible orders, There were thus 6 X 6 = 36 conditions of presentation combining the tests and materials. Each sub-group had 36 subjects as per the experimental design. One subject was tested under one of the 36 experimental conditions. Subjects were assigned to the above testing conditions at random.

In the investigation two sets of materials differing in size and colour were employed. The subjects were tested employing one set of materials, the smaller set painted orange, in the first instance. After the concerned subject were tested in 3 sessions using the small-sized materials, the Ss were administered the tests in the same order using the large-sized materials painted red.

All subjects were tested individually, and as far as possible under similar conditions. Each testing session lasted about 40 minutes. A few subjects required longer periods. Subjects were tested using strictly the same procedure. All instructions were given in the mother tongue of the children. Enormous care was taken to establish rapport with the subject before the tests were administered. Subjects were also given sweets for this purpose.

Every subject was taken charge from his or her home and brought for testing. After the subject was familiarized whith the situation and its surrounds. the subject was given the following :

A numerosity Test (Not Counting) : Subjects were presented with 5 problems in a serial order. Subjects were presented with two heaps of 3, 5, 7, 9 and 11 chips in that order and asked to judge which heap had more and which less Irrespective of whether a subject passed a test or not he/she was given 3 consecutive tests.

The subjects were given number conservation tasks at the commencement of the first testing session Number conservation was tested employing buttons and wooden sticks. Subjects were given five problems each containing 4, 6, 8 10 and 13 items in that order. The subjects were next given the three tests (discrimination, seriation and numeration) in accordance with the order of presentation randomly assigned to him/her. Between any two testing sessions there was an interval of 7 days.

After the testing in three sessions was gone through, the subject was tested using the other set of larger-sized red-painted materials after an interval of a week. The same order, as employed previously, was followed for testing in the second series.

After the second set of three sessions, the subject was administered a mental ability test (Draw-a-man Test). The numerosity and conservation tests were not repeated.

Following the procedure as above, 144 X 4 = 576 subjects were tested in the investigation. However, to overcome any loss of subjects during the course of investigation over-sampilng to the extent of 25 percent in the case of school going and 50 percent in the case of non-school going subjects was restored to. From the available data thus collected, data for 576 subjects alone in accordance with the experimental design of the investigation were analysed discarding the other data.

Discarding of some data would obviously affect the sample To overcome this difficulty extra data over what was required as per the experimental design was discarded randomly such that the essential nature of the sample was not adversely affected.

RESULTS

The main variables for the present study were schooling/no-schooling, tests, materials and age. The data were analysed to examine whether differences in age, schooling, no-schooling contribute to variation in the development of number concepts in young children as evidenced by their performance on the tests of discrimination, seriation and numeration, with different kinds of materials. The data were analysed for girls and boys separately.

In order to check the differences, if any, between boys and girls, data obtained were analyses for boys and girls independently A 2 X 3 X 3 X 4 factorial design was used in the study for boys and girls independently to check whether significant relationship existed between the variables. The data were tested for homogeneity by employing Bartlett's test of homogeneity (Edwards, 1950). As the obtained chi-square values were all not significant, analysis of variance was used to analyse the data. The analysis was made separately for the two series of materials used, i.e., large size and small size. Significance of difference between means was tested by 't' test wherever necessary. In addition, qualitative analysis of the subjects' responses was also made.

Little progress in understanding the nature of developmental processes involved in the acquisition of number in young children was made owing to the fact that most of the studies were cross-sectional in nature. To overcome this Scalogram analysis of the results was made. From his experimental studies with young children, Piaget found evidence to conclude that the development of the concept of number has its origin in functions essentially discriminative in nature, proceeding there from to seriation and finally to numeration. The present study was designed to check this conclusion of Piaget.

TABLE 2 — Bartlett's Test of Homogeneity for the Scores of Discrimination Test for Series I.

Age	N	df	S^2	Log S^2	X^2
4	108	107	11.82	1.8638	3.7942 @
5	108	107	5.54	0.5161	3.3261 @

Age	N	df	S^2	Log S^2	X^2
6	108	107	2.30	1.0311	5 8145 @
7	108	107	0 39	2 5775	7.0800 @

@ Not significant at 0 05 level.

Table 2 presents that data for Bartlett's test of homogeneity for series I for discrimination scores. It was assumed that seriation and numeration scores would also be homogeneous as the subjects were the same individuals. Tables 3 to 6 show results of analysis of variance for series I and II respectively,

Since the subjects were tested on three operations employing three kinds of materials for each operation, the repetitions of tasks could account for some amount of variance in the experiment. As it was not possible to make this factor a systematic feature of the experiment the next best alternative procedure was employed namely, each test was randomly presented to the subject. The order of presentation of the tasks and their repetitions were randomized. By following this procedure the possible effects of order were effectively "mixed up" with the possible effects of individual subjects. Hence, the analysis appropriate to the design, viz., the mixed model of analysis of variance was used.

Tables 3, 4, 5 and 6 present analysis of variance of scores for the three operations for the subjects – boys and girls for each series I and II independently.

TABLE 3 — Analysis of Variance of the Scores of Boys on Discrimination, Seriation and Numeration Operations with three kinds of Materials viz., Blocks, Slats and Sticks at the four Age levels Schooling-wise for Series I.

Source of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Age)	2209.46	3	736.48	545.55**
B (Operations)	4667.02	2	2333.51	27.80**

Source of Variation	Sum of Sqnares	df	Mean Sum of Squares	F
C (Materials)	645 02	2	322.51	8.405**
D (Schooling)	2293.14	1	2293.14	63.76**
AB	503.67	6	83.94	62.18**
AC	230.27	6	38.37	28.42**
AD	107.88	3	35.96	26.63**
BC	564.64	4	141.16	20.52**
BD	1399.89	2	699.94	10.415**
CD	51.53	2	25.76	102 629**
ABC	82.63	12	6.88	5.29**
ABD	403.20	6	67.20	49.77**
ACD	1.51	6	0.251	—
BCD	21.55	4	5.38	3.98**
ABCD	14.16	12	1.18	0.874
Error	3411.44	2520	1.35	
Total	16607.01	2591		

** Significant beyond .01 level.

From Table 3 it would be seen that F ratios for the factors,–age, operations, materials and schooling , were found significant beyoud the 0.01 level of confidence. The interactions AB, AC, AD, BD, CD were also significant and the second order interactions ABC and ABD and BCD were also significant. In keeping with the requirements for analysis of a mixed model the F tests were made employing appropriate interaction values as denominators Thus MSb/MSab, MSc/MSac, MSd/MSad, MSbe/MSabc, MSbd/MSabd, MScd/MSacd were all found to be significant beyound the 0.01 level. For the other mean squares MS error was used as denominator. As a further check a/ac, a/ab, a/ac, a/ad, b/bd, c/cd, c/ac, c/bc, d/ad, d/bd, d/cd, b/abc, b/bcd, c/bcd were also found to yield significant F ratios for the respective degrees of freedom. Table 4 presents the ANOVA for the scores for the girls. The F ratios for the main factors A, B, C, D, first order factors AB, AC, BD, CD and second order factors ABC, ABD and BCD were all found to be significant. The F ratios were obtained employing appropriate denominator values as above (Table 3).

TABLE 4 — Analysis of Variance of the Scores of Girls on Discrimination, Seriation and Numeration Operations with three kinds of Materials viz., Blocks, Slats and Sticks at the four Age levels Schooling-wise for Series I.

Source of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Age)	2297.513	3	765.837	659.068**
B (Operations)	5964.130	2	2982.065	31.971**
C (Materials)	533.783	2	266 891	12 676**
D (Schooling)	2238.920	1	2238.920	1294.173**
AB	559.648	6	93.274	80.270**
AC	126.308	6	21 051	12.116**
AD	75.190	3	55.063	21.569**
BC	1070.983	4	267.745	27.171**
BD	1498.155	2	749.077	16.124**
CD	33.100	2	16.550	29.035**
ABC	118.258	12	9 854	8.480**
ABD	278.744	6	46 457	39.910**
ACD	3.425	6	0.570	—
BCD	28.648	4	7.162	6.163**
ABCD	23.195	12	1.162	1.662
Error	2928.330	2520		
Total	17778.330	2591		

** Significant beyond .01 level.

Table 5 present the analysis of variance of the scores of boys with a second set of materials (Series II). The F ratios for the main factors A, B, C, D, the first order factors AB, AC, AD, BD and CD and second order values for ABC, ABD and BCD were found to be significant beyond the 0.01 level usingthe appropriate error terms as above. Table 6 presents the analysis of variance for the scores of girls obtained with second set of materials (Series II). As has been observed with the preceding analyses the results obtained were found to be significant for the main factors A, B, C, D and the first order factors ABC, ABD and BCD were found to be significant. The results of the four tables were in agreement with one another. In all the four analyses it was seen that the first order interration B × C, and the second order interaction A × C × D and the third order interaction A×B×C×D were all not singificant. The results suggest that the main factors of the experiment namely age, schooling/absence of schooling, operations of discrimination, seriation and numeration as well as the materials, - unidimensional, two dimensional and tridimensional contribute to variance in the performance of the subjects both boys and girls. As the obtained F ratios were significant, detailed examination of the means was made to test the significance of difference employing the 't' test.

TABLE 5 — Analysis of Variance of the Scores of Boys on Discrimination, Seriation and Numeration Operations with three kinds of Materials viz., Blocks, Slats and Sticks at the four Age levels Schooling-wise for Series II.

Source of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Age)	1825.268	3	608.422	474.218**
B (Operations)	4211.350	2	2105.675	24.547**
C (Materials)	311.704	2	155 952	11.240**
D (Schooling)	3223.550	1	3223.550	101.827**
AB	514.672	6	86.778	66.857**
AC	83.198	6	13.866	10.807**
AD	94.972	3	31.657	24.674**
BC	1052.786	4	263.196	57.316**
BD	2600.870	2	1300.435	41.730**
CD	68.396	2	34.198	35.997**
ABC	55.112	12	4.592	3.579**
ABD	186.978	6	31.163	24.289**
ACD	5.702	6	0.950	—
BCD	18.484	4	4.617	3.598**
ABCD	31.468	12	2.622	2.043**
Error	3234.950	2520	1.283	
Total :	17519.460	2591		

** Significant beyond .01 level.

TABLE 6 — Analysis of Variance of the Scores of Girls on Discrimination, Seriation and Numeration Operations with three kinds of Materials viz., Blocks, Slats and Sticks at the four Age levels Schooling-wise for Series II.

Source of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Age)	1634.000	3	544.666	520.215**
B (Operations)	4408.090	2	2204.045	24 793**
C (Materials)	247.530	2	123.765	15.195**
D (Schooling)	3462.970	1	3462.970	143.930**
AB	533.380	6	88.896	84.905**
AC	48.870	6	8.145	7.779**
AD	72.180	3	24.060	22.979**
BC	1023.110	4	255.777	45.270**
BD	3151.760	2	1575.880	65.522**
CD	46.510	2	23.255	96.895**
ABC	67.800	12	5.650	5.396**
ABD	144.310	6	24.051	22.971**
ACD	1.440	6	0.240	—
BCD	24.550	4	6.137	5.861**
ABCD	18.170	12	1.514	1.446
Error	2639.950	2520	1.047	
Total	17524.620	2591		

** Significant beyond .01 level.

In his experiments, Piaget found that discrimination items were easy and passed by 4 year old children. The seriation items were higher in difficulty and the 4 year old children rarely passed them. The numeration items were most difficult and could not be passed until the children reached 6 or 7 years. The experimental design used by Piaget as reported in his number conception book was to demonstrate stages in the development of particular conceptions. A second purpose was to demonstrate the development of a conceptualizing ability. Piaget's experiments suggest that the conceptualizing ability derives from internalization of the child's grouping, ordering and counting operations. Piaget devised such problems which could be dealt with by the manipulation of concrete materials. By studying the child's grouping, ordering and counting activities, Piaget inferred the stages in the development of conceptualizing ability.

Age: From Tables 3 to 6 it would be seen that the F ratios for the age levels were highly significant at the 0.01 level. The means for the sub-groups were examined at a greater length and Tables 7, 8 and 9 present the significance of difference between different age groups for discrimination, seriation and numeration tasks respectively. As would be expected, the abiiity to discriminate or seriate or numerate improves with age.

Piaget's observations imply significant differences between 4, 5, 6 and 7 year old children in the ability to discriminate, to seriate and to numerate. In the present study, the F ratios for series I and series II were significant beyond the 0 01 level (Tables 3, 4, 5 and 6) for the four age groups. Individual 't, tests for the differences between the means revealed that they were significantly different from one another at the .01 level. The increase with age in the size of the mean scores on the tests of discrimination, seriation and numeration is in agreement with Piaget's findings.

Tests :

In his experiments, Piaget found the discrimination items to be least difficult, the seriating items to be of intermediate level of difficulty, and the numerating items to be most difficult. The results of the present study yielded the F ratios for series I and series II, for the three tests, signiflcant bevond the .01 level. The means for the three tests presented in Tables 8, 9 and 10 were significantly different from one another as shown by the 't' test results (Table 7). Item analysis showed that the last item in the discrimination test viz., pointing the largest stick when disguised was the most difficult. However, the subjects found items involving two and one dimensional materials relatively more difficult than items with the three dimensional materials. The relative difficulty of the tests with the different of materials, three dimensional, two dimensional and undimensional is consistent with Piaget's results.

Materials :

Piaget does not appear to have attached much importance to the dimensional characteristics of the test materials. He did, of course, suggest that the more perceptible the differences; the more easily they would be mastered. In this study, this sugestion, viz., differences owing to perceptibility was tested by varying the dimensionality of the materials by using blocks - three dimensional ; slats - two dimensional ; and sticks - unidimensional. This was done on the assumption that variation in dimensionality could affect successful or unsuccessful discrimination, seriation and numeration. The obtained F ratios for serious I and series II were significant beyond the .01 level. The individual means for blocks, slats and sticks for Series I and Series II are presented in Tables 12, 13 and 14 respectively. The 't' tests for the difference between means yielded values significant beyond the .01 level The findings of this study corroborate Piaget's suggestion regarding the infiuence of perceptibility of size differences. For all the subjects increase in the dimensionality of materials was of significant assistance in discrimination, seriation and numeration tests.

Schooling and Non-Schooling

Piaget holds that the cognitive development follows an invariant sequence. The differences in the environment could influence the early or late acqusition of a concept. But in a given situation the several stages in the development of a concept would be invariant. The difference, if any, would be in the size of scores made by the subjects hailing from different environments. To examine this, in the present study, the subjects from the school going population and subjects from the non-schooling population were studied (page No. 49). The obtained F ratios for Series 1 and II were significant at the 0.01 level. The means for the different age group were found to be significantly different from one another on applying the 't' test. The results indicate that there were marked differences in discrimination, seriation and numeration scores of the two groups of subjects;

Schooling × Tests

The obtained F ratios for both Series I and Series II were significant. If the tests were performed by the two groups of subjects significantly differently and such a difference in their test performance was owing to schooling or absenae of it, significant interaction between schooling and tests would be obtained. The obtained results were in keeping with the above. The F ratios for both the series were significant beyond the 0.01 level. This underscores the importance of schooling as a positive factor in cognitive development.

Schooling × Materials

In this investigation materials varying in dimensionality (viz., cubes, slats and sticks) were employed to determine the effect of perceptual cues. The differences between schooling and non-schooling groups should remain relatively the same for each material. This may be independent of the absolute size of the scores with each of the different materials. A significant interaction of schooling and materials suggest that schooling or absence of it affects the perception of dimensional cues by the subjects. The F ratios for the two series were both significant at 0.01 level suggesting that schooling has a differential effect in the manner in which dimensional cues were perceived by the subjects.

Schooling × Age

If the performance of the subjects in the schooling and non-schooling groups were to vary from one age level to another, indicating the differential infiuence of schooling, a significant F ratio would be obtained. In this study the obtained F ratios for both the series were significant beyond the 0.01 level suggesting the differential influence of schooling on age.

Tests × Age

The difference in performance between tests of discrimination, seriation and numeration should decrease with age because of the increased conceptual ability of the older children. The differences between the three tests namely, discrimination, seriation and numeration at each age level would appear as significant test × age interaction. The obtained F ratios for the two series were significant beyond the 0.01 level. This suggests that increase in age affects performance of tests differently.

Tests × Materials

In this investigation the tests were given employing materials differing in dimensionality. Therefore, the effect of varying size differences may result in different scores depending on whether the tests are easy or difficult. In other words, varying the perceptibility of size differences may not have much effect with easy items while with difficult ones influence of perceptibility of size differences may be marked. If this were be true, the tests × materials interaction should be significant. In this investigation the obtained F ratios for boys and girls with series I and series II were significant beyond the 0.01 level suggesting that the dimensionality of materials significantly influenced the operations of discrimination, seriation and numeration with the subjects.

Materials × Age

The differences between the age groups would remain relatively the same for each material although the size of the scores may vary from one material to another. If this were to be true, the age × materials interaction would not be significant. A significant interaction effect would necessarily warrant rejection of the hypothesis that the effect of age is same for all the materials. The obtained F ratios for both the series were sginificant beyond the 0.01 level suggesting that perceptibility of size differences affects score differences between age groups on different materials. This finding is at variance with Piagetian view, that perceptibility of size differences affects absolute score differences but not relative score differences between age groups on different materials.

Schooling × Tests × Materials

The significant F ratios obtained for interaction effect of schooling x tests x materials suggest that the effect of particular tests and materials would be different for the schooling and the non-schooling groups.

Schooling × Tests × Age

The significant F ratios obtained for interaction between schooling x tests x age suggest that the effect of tests at different age levels would be different for the schooling and the non-schooling subjects. The school going subjects did significantly better on some of the tests while the non-school going subjects performed poorly on the same tests.

Tests × Materials × Age

The interactions between tests x materials x age for the two series were significant beyond the 01 level suggesting a significant influence of materials and age levels on the preformance of different test, and the obtained results were not altogether unexpected as we have found the dimensional differences of the materials as well as age levels of the subjects significantly influenced the performance on different tests.

All other interactions were not significant even at the .05 level.

Tests

From the analysis of variance for the two series of data presented in Tables 3 to 6 it would be seen that the F ratios for tests (discrimination, seriation and numeration operations) were significant beyond the .01 level. The data were further analysed by applying the 't' tests. Table 7 presents the differance between mean scores for the different operations (discrimination, seriation and numeration) age-, schooling- and sex-wise. At the 4 year level the difference between discrimination and seriation: discrimination and numeration; seriation and numeration were all significant beyond the .01 level. The results for the 5 year age level also conform to the above by and large. It was at the 6 year level that some differences were non-significant. This finding was limited to the group of school going boys only. The remaining groups tended to follow the same pattern. Except at the 7 year age level the differences, for boys as well as girls, of the school going groups were significant for all the other age groups.

The older children would be expected to perform better than the younger children for they have two distinct advantages, namely, they would have reached higher levels of maturation and secondly they would have had richer and wider experiences which would help stimulate their cognitive growth. For this reason, the older children would be expected to perform both quantitatively and qualitatively better than the younger children. The obtained results presented in Tables 7, 8 and 9 show that the older children performed much better than the younger children. In the light of the results as above, the hypothesis that age differences would be significantly related to differences in the development of discrimination, seriation and numeration abilities was retained as fully warranted.

TABLE 7 — Significance of Difference between Mean Discrimination Scores ('t' tests) of School Going and Non-school Going Boys and Girls from different Age Groups.

	SERIES I				SERIES II			
	Boys		Girls		Boys		Girls	
Age	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means
4–5	1.55**	1.39**	1.28**	2.11**	0.57**	1.60**	0.47**	0.78**
4–6	2.61**	2.95**	1.84**	2.73**	1.05**	2.07**	0.95**	1.36**
4–7	3.17**	3.39**	2.73**	3.56**	1.40**	2.44**	1.33**	1.72**
5–6	1.06**	1.56**	0.56**	0.62**	0.48**	0.47**	0.48**	0.58**
5–7	1.62**	2.00**	1.45**	1.45**	0.83**	0.84**	0.86**	0.94**
6–7	0.56**	0.44*	0.83**	0.83**	0.35*	0.37*	0.38*	0.36*

SD = 0.19; N_1 = 36. N_2 = 36; **SD** = 0.18; N_1 = 36; N_2 = 36;
1% Level = .490; 5% Level = .372; 1% Level = .464; 5% Level = .352.

(Garrett, 1958; P 281)

** Significant at .01 level; * Significant at .05 level.

Figures 1–6 present the performance of the four sub-groups of subjects, — school going boys, non-school going boys, school going girls, non-school going girls –, on the different operations of discrimination, seriation and numeration tests age-wise for Series I and II.

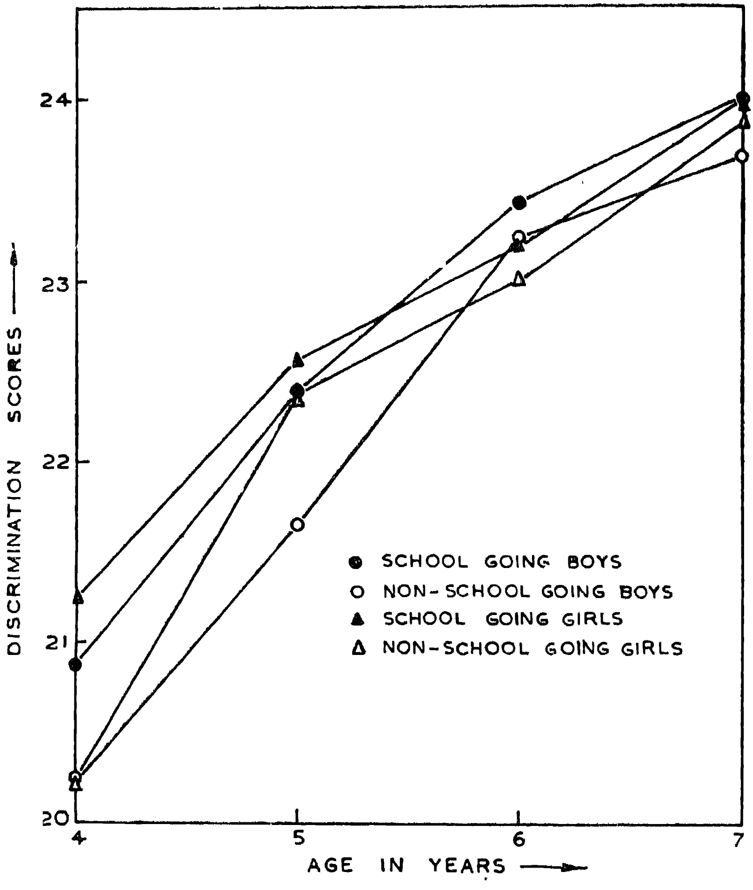

FIG. I DISCRIMINATION SCORES OF THE FOUR SUB-GROUPS AGE-WISE FOR SERIES I

It would be seen that the performance of all the subjects from the four sub-groups was satisfactory even at the 4 year age level. The subjects at the successive age levels improved in their performance. The lowest possible score for the discrimination tests was zero and the maximum possible score was 24. The subjects scored above 20 at the 4 year age level showing that by that age they were able to easily discriminate. The improvement at 5, 6, and 7 year age levels was only of a marginal nature. The improvement was perhaps largely owing to familiarization with the materials.

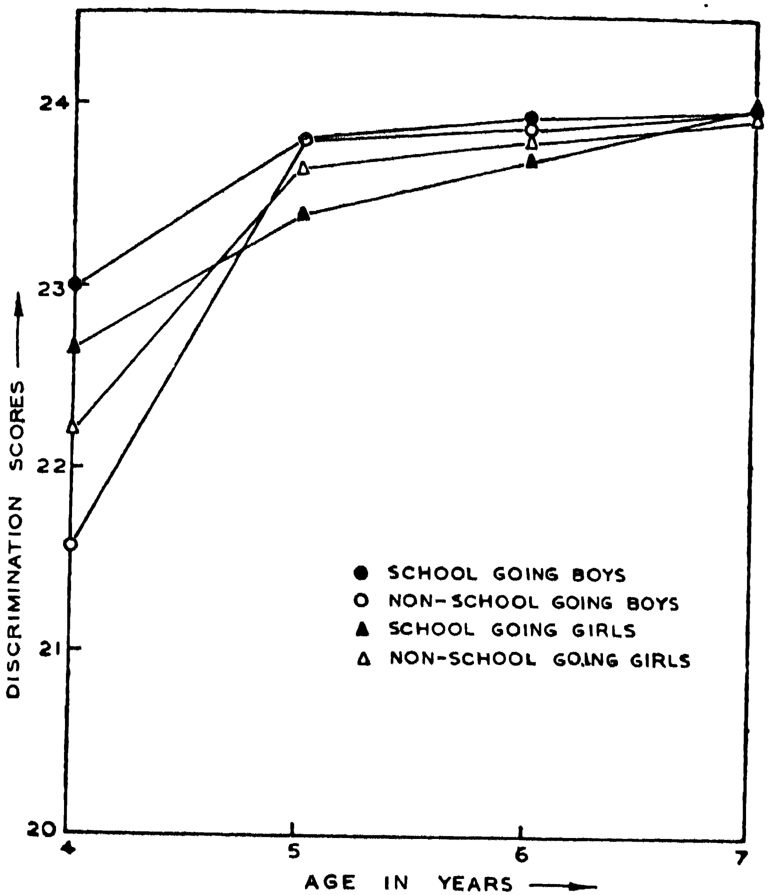

FIG. 2 DISCRIMINATION SCORES OF THE FOUR SUB-GROUPS AGE-WISE FOR SERIES II

Figure 2 presents the discrimination scores for the four sub-groups age-wise for Series II. The results show that children at 4 year age level perform reasonably well in comparison to the performance of older children of 5, 6 and 7 years of age. The scores obtained were not in any way lower. The results presented in figures 1 and 2 compare favourably. The results in figure 2 show slight improvement in performance over the results presented in figure 1. This observed improvement should be owing to familiarization with the tasks.

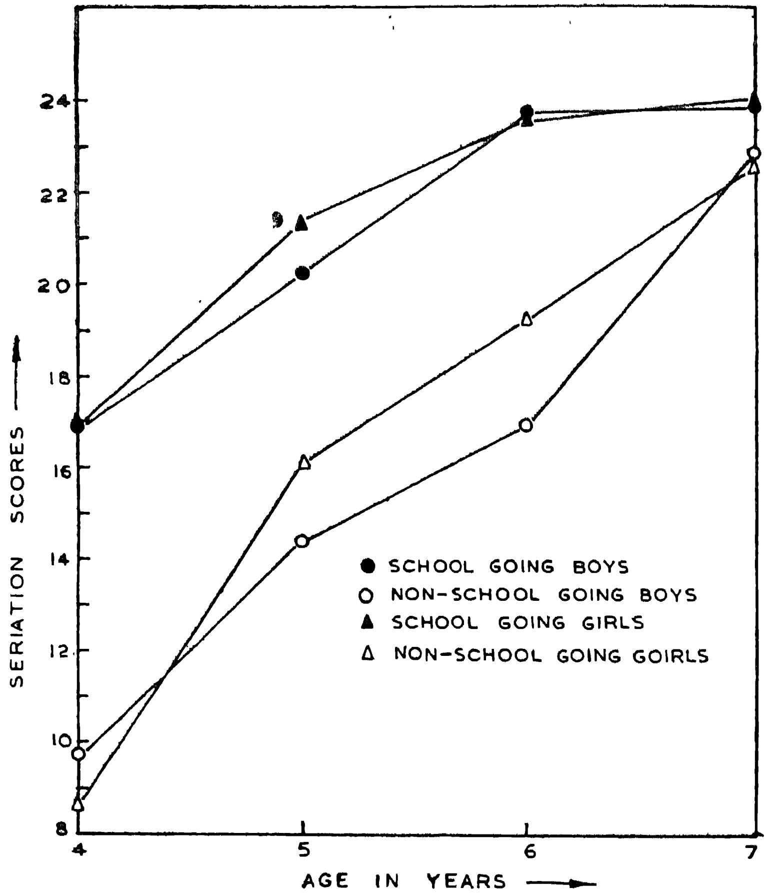

FIG.3 SERIATION SCORES OF THE FOUR SUB-GROUPS AGE-WISE FOR SERIES I

Figures 3 and 4 present the data for seriation scores., for the four sub-groups age-wise. As in the case of figures 1 and 2, figures 3 and 4 appear closely similar. There is a small im-

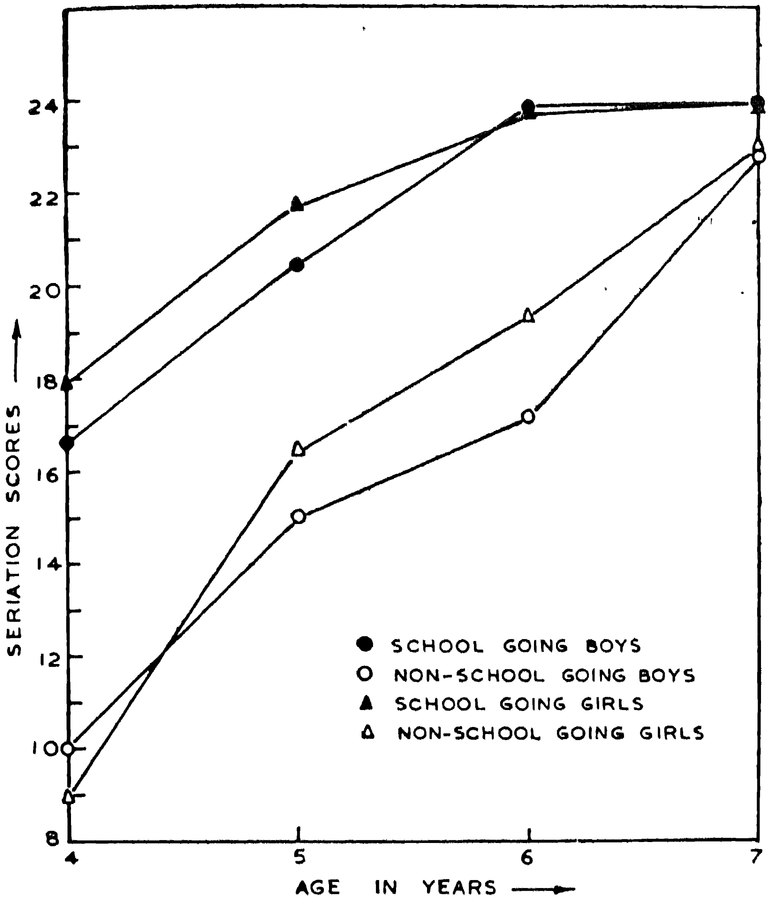

FIG. 4 SERIATION SCORES OF THE FOUR SUB-GROUPS AGE-WISE FOR SERIES II

provement in performance of the subjects on the seriation tests as shown in figure 4 with series II over the results shown in figure 3 for series I. In distinction from discrimination, seriation was obviously a more difficult task for the children to perform. The lowest possible score for seriation was zero and the highest was 24 At 4 year level the subjects obtained a relatively lower score of 8.5 and the 7 year old subjects obtained scores between 21 and 24 showing thereby that the seriating ability of the subjects increased with age. Comparison of figures 3 and 4 for series I and II reveals that there was no appreciable improvement in performance owing to practice and familiarization with the tasks. This points to the fact that seriating performance was largely age dependent. The figures 3 and 4 reveal a very striking feature. The performance of school going subjects, was unmistakably higher than that for the non-school going subjects, irrespective of sex differences. This was borne out by the results obtained with series I as well. The results obtained

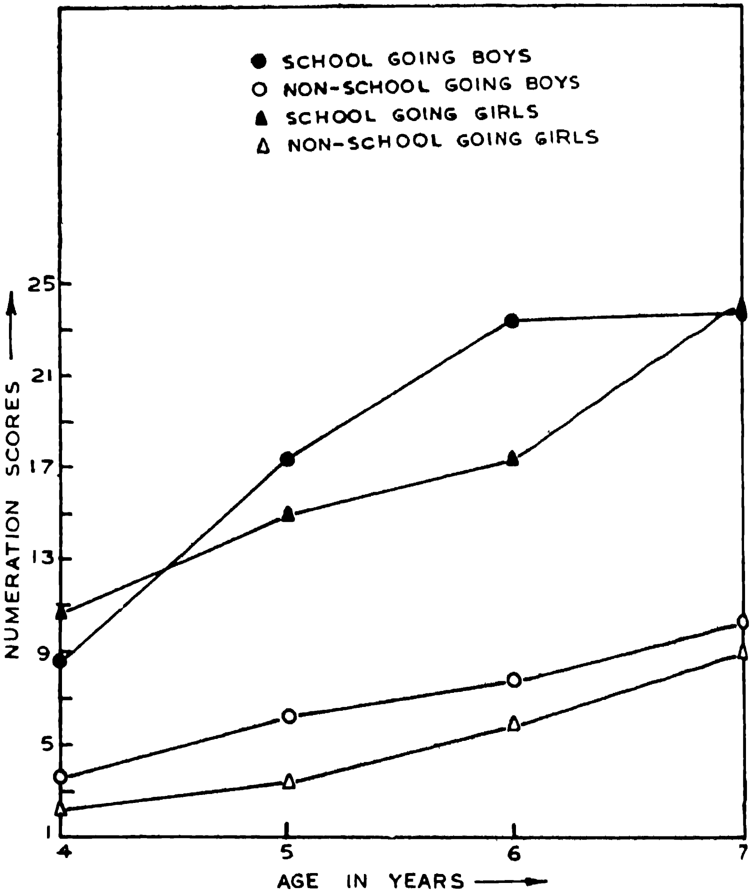

FIG. 5 NUMERATION SCORES OF THE FOUR SUB-GROUPS AGE-WISE FOR SERIES I

therefore show that seriation apart from being dependent on age was significantly affected by schooling or absence of it. Children attending schools have performed better on seriation tasks at all age levels 4 through 7 showing that schooling is a source of important stimulation for cognitive growth.

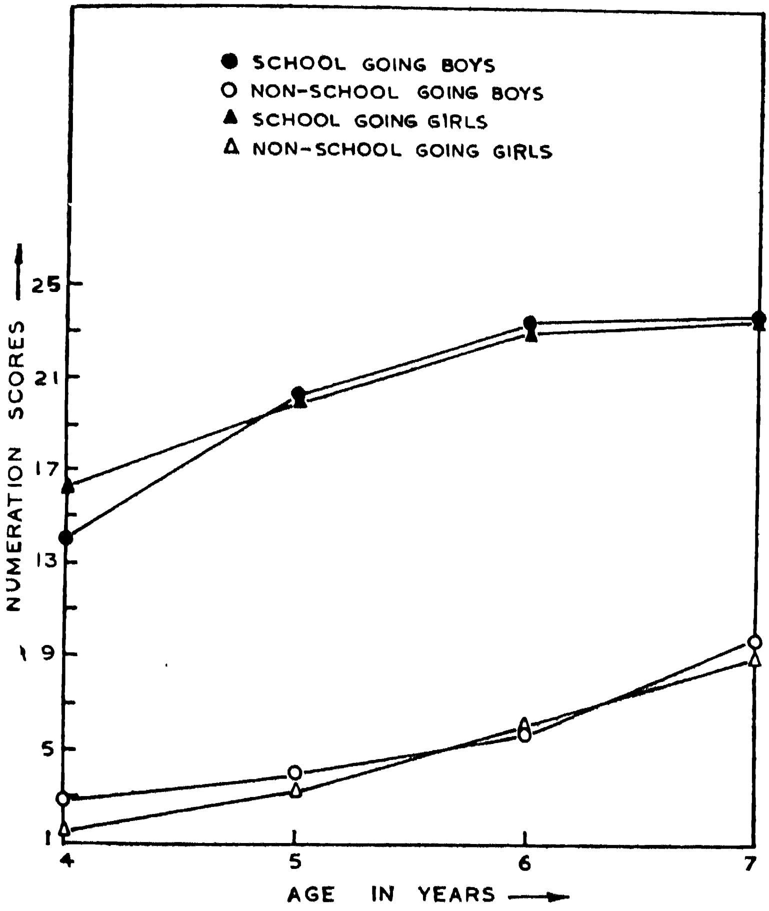

FIG.6 NUMERATION SCORES OF THE FOUR SUB-GROUPS AGE-WISE FOR SERIES II

Figures 5 and 6 present the numeration test scores for the subjects age-wise. Unlike the results obtained with discrimination and seriation tests, the results found with numeration, appear to be significantly different in several important respects. First, the 4 year old children scored very low compared to the 7 years old children. Second, the children who had the benefit of schooling performed much better than those who did not attend school, In the case of the school going subjects the numeration scores were significantly higher than the same for the non-school going subjects. Third, the results obtained show that ability to numerate was not only dependent on age but perhaps more so on schooling. Four, there were no sex differences with regard to the three operations studied here, viz., discrimination, seriation and numeration.

The results therefore suggest that the hypothesis that a distinct stage sequence cannot be found in the development of discrimination, seriation and numeration is unwarranted and needs to be rejected.

TABLE 8 — Significance of Difference Between Mean Seriation Scores ('t' tests) of School Going and Non-School Going Boys and Girls from Different Age Groups for Series I and II.

	SERIES I				SERIES II			
	Boys		Girls		Boys		Girls	
Age	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means
4–5	3.28**	4.69**	4.45**	7.52**	3.89**	5.00**	3.78**	7.48**
4–6	6.78**	7.25**	6.72**	10.64**	6.79**	7.19**	5 23**	10.39**
4–7	7.00**	13.11**	7 06**	14.05**	7.31**	12,88**	6.11**	14.06**
5–6	3.50**	2 56**	2.28**	3.12**	2.90**	2.19**	1.45**	2.91**
5–7	3.72**	8.42**	2.62**	6.53**	3.42**	7.88**	2.33**	6.58**
6–7	0.22	5.86**	0.34	3.41**	0.52**	4.69**	0.88**	3.67**
SD = .19;		N$_1$ = 36;	N$_2$ = 36;		SD = .18;	N$_1$ = 36;	N$_2$ = 36;	

1% Level = .490; 5% Level = .372; 1% Level = .464; 5% Level = .352.

**Significant at 0.01 level. (Garrett, 1958; p. 281)

TABLE 9 — Significance of Difference Between Mean Numeration Scores ('t' tests) of School Going and Non-School Going Boys and Girls from Different Age Groups for Series I and II.

	SERIES I				SERIES II			
	Boys		Girls		Boys		Girls	
Age	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means
4–5	8.70‡‡	2.44‡‡	4.19‡‡	1.28‡‡	6.17‡‡	1.17‡‡	3 64‡‡	1.91‡‡
4–6	14.70‡‡	4.19‡‡	6.47‡‡	3.66‡‡	9.07‡‡	3.11‡‡	6.18‡‡	4.58‡‡
4–7	15.14‡‡	6.83‡‡	13.11‡‡	6.78‡‡	9.92‡‡	7.00‡‡	7.50‡‡	7.72‡‡
5–6	6.00‡‡	1.75‡‡	2.28‡‡	2.38‡‡	2.90‡‡	1.94‡‡	2.54‡‡	2.67‡‡
5–7	6.44‡‡	4.39‡‡	8.92‡‡	5.50‡‡	3.75‡‡	5.83‡‡	3.86‡‡	5.81‡‡
6–7	0.44‡	2.64‡‡	6.64‡‡	3.12‡‡	0.85‡‡	3.89‡‡	1.32‡‡	3.14‡‡

SD = .19; $N_1 = 36$; $N_2 = 36$;

1% Level = .490; Level = .372;

SD = .18; $N_1 = 36$; $N_2 = 36$;

1% Level = .464; 5% Level = .352.

‡Significant at 0.05 level.

‡‡Significant at 0.01 level.

(Garrett, 1958; p. 281)

TABLE 10 — Difference Between Means of Different Operations (Discrimination, Seriation and Numeration) Age–, Schooling–, and Sex–wise and level of Significance ('t' Test).

Age	Tests	Series I				Series II			
		Boys		Girls		Boys		Girls	
		Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means
4	D–S	3 87‡‡	10.45‡‡	5.33‡‡	11.56‡‡	5.91‡‡	11.56‡‡	4.78‡‡	13.28‡‡
	D–N	12.20‡‡	16.55‡‡	10.52‡‡	18.05‡‡	8.55‡‡	18.73‡‡	6.31‡‡	20.80‡‡
	S–N	8.31‡‡	6.00	5.19‡‡	6.39‡‡	2.64‡‡	7.17‡‡	1.00‡‡	7.52‡‡
5	D–S	2.16‡‡	7.25‡‡	1.17‡‡	6.25‡‡	2.59‡‡	8.16‡‡	1:47‡‡	6.58‡‡
	D–N	5.05‡‡	15.50‡‡	8.61‡‡	18:88‡‡	2.95‡‡	19.16‡‡	3.14‡‡	19.67‡‡
	S–N	2.89‡‡	8.25‡‡	6.44‡‡	12.63‡‡	0.36‡	11.00‡‡	1.67‡‡	13.09‡‡
6	D–S	0.28	8.25‡‡	0.55‡‡	3.75‡‡	0.17	6.44‡‡	0.50‡‡	4.25‡‡
	D–N	0.38‡	15.32‡‡	5.89‡‡	17.15‡‡	0.53‡‡	17.69‡‡	1 08‡‡	17.58‡‡
	S–N	0.39‡	9 06‡‡	6.44‡‡	13.40‡‡	0 36‡	11.25‡‡	0 58‡‡	13.33‡‡
7	D–S	0 06	0.83‡‡	—	1.17‡‡	—	1.12‡‡	—	0.94‡‡
	D–N	0.23	13.11‡‡	0.14	14.83‡‡	0.03	14.12‡‡	0.14	14.80‡‡
	S–N	0.17	12.28‡‡	0.14	13.66‡‡	0.03	13.00‡‡	0.14	13.86‡‡

SD = .19; N_1 = 36; N_2 = 36;
1% level = .490; 5% level = .372;
‡‡ Significant at .01 level;

(Garret, 1958, p. 281)

SD = .18; N_1 = 36; N_2 = 36;
1% level = .464; 5% level = .352.
‡ Significant at .05 level

At the 4 year level, children were able to discriminate reasonably well, but they were not able to either seriate or numerate. High scoring subjects on discrimination have been found to make very low scores in seriation and numeration. This finding was common to all the four groups of subjects with both the series I and II. Subjects with low discrimination scores at all age levels, if any, have obtained low seriation and numerating scores. But their discrimination scores were high. Subjects with low seriation scores have consistently obtained low numeration scores but their discrimination scores were high. This suggests that the cognitive structures involved in discrimination appear first and the subjects who have reached the seriation stage would have necessarily attained the structures concerned with discrimination. Similarly subjects with high numeration scores *ipso facto* obtained high seriation and high discrimination scores. Whereas, subjects with low numeration scores made high discrimination and seriation scores. From an examination of the scores of the four groups of subjects at the different age levels 4 through 7 years, it would be seen that the three functions, discrimination, seriation and numeration appear in that order. Therefore, it could be said that the numeration ability, if achieved, would imply that the other abilities, namely, seriation and discrimination would also have been attained Non-achievement of numeration does not imply non-achievement of seriation and discrimination.

TABLE 11 — 't' Test of the Difference Between Mean Scores of Subjects from Different Sub-Groups Age–, Schooling– and Sex–wise with Different Materials Blocks (B), Slats (S) and Sticks (St). for Series I and II. (Sch = Schooling N-Sch = Non–Schooling)

		Series I				Series II			
		Boys		Girls		Boys		Girls	
Age	Mate-rials	Sch	Non–Sch	Sch	Non–Sch	Sch	Non–Sch	Sch	Non–Sch
4	B–S	1.42*	2.23*	1.47*	2.20*	1.33*	1.89*	0.72*	1.83*
	B–St	5.67*	7.55*	7.05*	6.39*	2.75*	6.14*	2.39*	3.75*
	S–Bt	4.25*	5.33*	5.58*	4.19*	1.42*	4.25*	1 67*	1.92*
5	B–S	1.17*	1.86*	0.33	1.16*	0.78*	1.25*	0.56*	0.95*
	B–St	3.25*	5.89*	3.17*	4.22*	1.30*	3.41*	0.56*	3.67*
	S–St	2.08*	4.03*	2.84*	3.06*	0.50*	2.16*	1.16*	2.72*
6	B–S	0.25	1.45*	0.84*	1.05*	0.31	1.28*	0.36§	1.00*
	B–St	1.14*	3.36*	0.95*	3.30*	0.50*	2.97*	0.81*	2.55*
	S–St	0.89*	1.91*	0.40§	2.25	0.50*	1.16*	0.58*	1.55*
7	B–S	0.09	0.58*	—	1.14*	0.03	0.78*	0.03	0.86*
	B–St	0.14	1.91*	0.14	2.47*	0.06	1.92*	0.12	1.86*
	S–St	0.05	1.33*	0.14	1.23*	0.03	1.14*	0.08	1.00*

SD = .19; $N_1 = 36$; $N_2 = 36$; SD = .18; $N_1 = 36$; $N_2 = 36$;

1% level = .490; 5% level = .372 §Significant beyond the 0.05 level.

**Significant beyond the 0.01 level.

Thefore, on the basis of the results obtained in the study the null hypothesis that "a distinct stage sequence would not be found in the development of discrimination, seriation and numeration" was rejected as unwarranted.

TABLE — 12 Difference Between Means of School Going and Non-School Going Subjects Age- and Sex-wise and and Level of Significance ('t' test) for Discrimination Scores for Series I and II

Age	SERIES I Difference Between Means for Boys	 Difference Between Means for Girls	SERIES II Difference Between Means for Boys	 Difference Between Means for Girls
4	0.56††	1.00††	1.44††	0.45†
5	0.72††	0.17	0.40†	0 28
6	0.22	0.11	0.11	0.06
7	0.34	0.17	0	0.06

(Garrett, 1958; p. 281)

SD = .19; N_1 = 36; N_2 = 36; SD = .18; N_1 = 36; N_2 = 36;
1% level = .490; 5% level = .372; 1% level = .464; 5% level = .352
†† Significant at .01 level; † Significant at 0.5 level.

It would be seen from Table 12 that at the 4 year level difference between school and non-school going subjects were significantly different. The subjects who had the advantage of going to school consistently performed better than those who had no opportunity to go to school. The F tests made for the data series I and II in tables 3 and 4 yielded very significant F ratios for schooling and non-schooling. This was sought to be examined in detail by analysing the data for each of the tests discrimination, seriation and numeration age-and sex-wise. The mean difference for discrimination scores were significant for both the series I and II at the 4 year level. At the 5 year level the means for boys alone were significant. At the 6 and 7 year levels the difference were not significant. This suggests that at the early age of 4 years, experience of schooling plays an important role in helping the subjects to acquire skills underlying discrimination operation. But as the children grow older they seem to reach a stage when they are able to discriminate without much difficulty. This stage appears to be reached by children at or slightly before the 5 year level. From Table 12 another finding also appears to be significant. There were some differences between boys and girls at 4 to 5 year level. Girls appear to acquire the ability to discriminate much earlier or faster than boys. Hence, there were no significant differences for the girls at the 5 year age level. At the 6 and the 7 year levels the difference between means were not significant for all the sub-groups. This suggests that discrimination ability is attained by the children by about 5 year age level.

TABLE — 13 Difference Between Means of School Going and Non-school Going Subjects Age- and Sex-wise and Level of Significance ('t' Tests) for Seriation Scores for Series I and II.

Age	SERIES I		SERIES II	
	Difference Between Means for Boys	Difference Between Means for Girls	Difference Between Means for Boys	Difference Between Means for Girls
4	7.22††	8.33††	6.69††	8.95††
5	5.81††	5.25††	5.47††	5.25††
6	6.75††	4.41††	6.69††	3.39††
7	1.11††	1.34††	1.12††	1.00††

(Garrett, 1958; p. 281)

SD = .19; $N_1 = 36$; $N_2 = 35$; SD = .18; $N_1 = 36$; $N_2 = 36$;

1% level = .490; 5% level = .372; 1% level = .464; 5% level = 352.

†† Significant at .01 level.

Table 13 presents the difference between means for the boys and the girls at the different age levels for seriation scores. It would be seen that the obtained results were highly consistant, i.e., similar results were obtained both in series I and series II. The results show that schooling helps children to reach the seriating ability much more effectively than the non-school going children The size of the difference between means was significantly reduced for the 7 year level groups. However, all the differences, even at this age level, were highly significant. This suggests that by the time children reach 7 years of age they seem to make significant progress with regard to the seriating ability.

TABLE — 14 Difference Between Means of School Going and Non-School Going Subjects Age- and Sex-wise and Level of Significance ('t' Test) for Numeration Scores for Series I and II.

Age	SERIES I		SERIES II	
	Difference Between Means for Boys	Difference Between Means for Girls	Difference Between Means for Boys	Difference Between Means for Girls
4	4.91††	8.53††	11.22††	14.94††
5	11.17††	11.44††	16.22††	16.67††
6	15.42††	11.37††	17.58††	17.17††
7	13 22††	14.86††	14.14††	14.72††

(Garrett, 1958; Page No. 281)

SD = .19; N_1 = 36; N_2 = 36 SD = .18; N_1 = 36; N_2 = 36; 1% level = .490; 6% level = 372; 1% level = .464; 5% level = .352.

†† Significant at .01 level.

Table 14 presents the data for the groups with regard to numeration scores. The obtained results show that the mean differences for all the age groups were significant at the .01 level. The school going children have been found to be superior to children who have had no-schooling. The results presented in Tables 13 and 14 lead to the unambiguous conclusion that schooling plays a very significant part in the development of the cognitive functions of children.

To examine the difference between boys and girls 't' tests were made to check difference between mean scores. Tables 15, 16 and 17 present the 't' test values mean differences for discrimination, seriation and numeration respectively. From the Table 15 it would be seen that the means for boys and girls were significant for all the groups at the 4 year age level Even here, the non-schooling groups performed poorly in comparison with the school going groups. At the 5 yeara ge level the means were significant only for the non-school going groups. The school going groups of boys and girls did not differ from each other with regard to discrimination. At the 6 and 7 year age levels no mean differences were found to be significant for any group. Thus, the discrimination operation appears to have been attained reasonably well by the time children reach the 6 year age level. But at the earlier age levels namely 4 and 5 years there are significant differences between boys and girls. These differences disappear, of course, as children reach higher age levels.

TABLE – 15 Difference Between Means of Boys and Girls and Level of Significance ('t' Test) for Discrimination Test Scores Age–and Schooling-wise for Series I & II

	SERIES I		SERIES II	
Age	Schooling Difference Between Means	Non-Schooling Difference Between Means	Schooling Difference Between Means	Non-Schooling Difference Between Means
4	.44‡	.50‡‡	.38‡	.66‡‡
5	.17	.72‡‡	.11	.39‡
6	.33	.22	.22	.05
7	—	.17	—	.06

(Garrett, 1958; Page No. 281)

SD = .19; N_1 = 36; N_2 = 36; SD = .18; N_1 = 36; N_2 = 36;

1% Level = .490; 5% Level = .372; 1% Level = 464; 5% Level = .352.

‡‡Significant beyond 0.05 level;

‡Significant beyond 0.01 level.

TABLE — 16 Difference Between Means of Boys and girls and Level of Significance ('t' Test) for Seriation Scores Age - and Schooling-wise for series I and II.

	SERIES I		SERIES II	
	Schooling	No Schooling	Schooling	No Schooling
Age	Difference Between Means	Difference Between Means	Difference Between Means	Difference Between Means
4	1.10*	1.11*	1.20*	1.06*
5	1.16*	1.72*	1 307	1.42*
6	0.08	0 72*	0.16	2.14*
7	0.06	0.17	0.00	0.12

SD = .19. N_1 = 36; N_2 = 36; SD = .18; N_1 = 36; N_2 = 36; 1% level = .490; 5% level = .372, 1% level = .464; 5% level = .352; *Significant at .01 level. (Garrett, 1958; p. 281)

TABLE — 17 Difference Between Means of Boys and Girls and Level of Significance ('t' Test) for Numeration Scores Age -land Schooling-wise for Series I and II

	SERIES I		SERIES II	
	Schooling	No Schooling	Schooling	No Schooling
Age	Difference Between Means	Difference Between Means	Diference Between Means	Difference Between Means
4	2.12*	1.50*	2.31*	1 41*
5	2.33*	2.66*	0 36*	0.67*
6	6.11*	1.06*	0.35*	0.86*
7	0.09	0.46§	0.11	0.69*

(Garrett 1958; p. 281)

SD = .19; N_1 = 35; N_2 = 36; SD = .18; N_1 = 36; N_2 = 36; 1% level = .490; 5% level = .372; 1% level = .464; 5% level = .352. §Significant at .05 level; *Significant at .01 level.

With regard to the seriation operation similar results as above were obtained (Table 16) The mean differences between boys and girls at the 4 and the 5 year age levels were all significant At the 6 year age level only the means for the non-school going subjects differed. At the 7 year level there were no significant differences. For the numeration operation also, (Table 17) similar results as above, were found with the exception that the mean differences for school going subjects at the 7 year level alone did not significantly differ. Otherwise, all other means with regard to numeration, the differences for 4, 5 and 6 year age level groups as well as the 7 year non-school going groups significantly differed. The only group which did not differ significantly were the 7 year school going groups.

The obtained results were highly consistent and point to the suggestion that the three operations discrimnation, seriation and numeration were mastered at different age levels and depend on the kind of stimulations to which the subjects were exposed. At all the transitional stages, i.e.. stages when different operations appear to reach fully functioning level, differences between boys and girls seem to be significant Thus, for discrimination all the mean differences at the 4 year level were significantly different but at the 5 year level only those for the non-school going groups were significant. Thus, the 5 year age level was a stage that was critical as far as the discrimination operation was concerned. Subjects, 6 and 7 years old, did not show any differences, for all of them had perhaps attained this operation at a fully functioning level. With regard to seriation, the mean differences at the 4 and the 5 year levels and the mean differences for the non-school going groups at the 6 year level were significant. The mean differences for the 6 year school going groups and for all the age groups at the 7 year level were not significant. The 6 year level appears to a critical period when the seriation operation appears to be a critical period when the seriation operation appears to be fully acquired. With regard to numeration also a similar pattern was found. The differences at 4, 5 and 6 year age levels and the 7 year non-school going groups were all significant. This suggests a kind of sequential development of the discrimination, seriation and numeration operations.

Materials:

In this study the three operations namely discrimination, seriation and numeration were studied employing three types of materials. The materials were sticks linear — one dimensional, slats — two dimensional and cubes — tri-dimensional. The next hypothesis was concerned with the influence of perceptual cues. Tables 3 to 6 show significant F ratios for materials with both the series This suggests that the subjects' performance with different materials sticks, slats and cubes very much varied.

Table 11 presents the 't' test of the difference between mean scores with different materials. It would be seen from the tables above that the performance with blocks (three dimensional) was superior to the performance with the two dimensional slats and unidimensional sticks for all the tests at the four different age levels.

The 't' test (Table 11) made to test the significance of difference between the mean scores shows that the performance with different materials significantly differs at the .01 level at 4 and 5 year age levels. At the 6 year age level, the difference between blocks and sticks (three dimensional and unidimensional) and slats and sticks (two dimensional and unidimensional) were significant. The scores for blocks and slats (three dimensional and two dimensional) were not significantly different for the school going groups but they were significant for the non-school going groups This difference in performance between school going and non-school going groups was observed also at the 7 year level. While the scores for the school going groups did not significantly differ, they were significantly different for the non-school going groups. The difference between school going and non-school going groups is discussed in detail elsewhere The results obtained thus show that the perceptual cues play a very significant role in discrimination, seriation and numeration by the subjects. The interaction F ratios for tests and materials BXC for both the series were significant at the 0.01 level. The significant interaction effect suggests that the performance on different tests was not independent of the different cues which the materials presented. In view of the above, the null hypothesis that the operations of discrimination, seriation and numeration would not be affected by perceptual cues like dimensionality of the materials used was rejected as untenable.

The analysis of variance of the data for each of the groups, boys — school going and non-school going, girls — school going and non-school going, for series I and II, was summarized in Tables 18 to 25.

TABLE — 18 Analysis of Variance of the Scores of Boys with Repeated Measures on Operations (Discrimination, Seriation and Numeration) and Materials (Blocks, Slats and Sticks) at the Four Age Levels for the *School going Group* for Series I.

Source of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Age)	1654.039	3	551.346	150.476*
Subjects Wn. Groups Error (a)	512.997	140	3 664	-
B (Operations)	481.927	2	240.963	149.759*
AB	605.338	6	100.889	62.702*
BXSubjects Wn. Groups Error (b)	450.735	280	1.609	-
C (Materials)	167.844	2	83.922	195.167*
AC	115.070	6	19.178	44.600*
C X Subjects Wn. Groups Error (c)	120.419	280	0.430	-
BC	35.563	4	8.890	25.843*
ABC	48.672	12	4.056	11.790*
BC X Subjects Wn. Groups (Error (bc)	193.107	560	0.344	-
Total	4385.711	1295		

*Significant beyond 0.01 level

TABLE—19 Analysis of Variance of the Scores of Boys with Repeated Measures on Operarions (Discrimination, Seriation and Numeration) and Materials (Blocks, Slats and Sticks) at the Four Age Levels for the *Non-school Going Group* for Series I.

Source of Variation	Sum of Squares	df	Mean sum of Squares	F
A (Age)	1163.311	3	387.770	74.830*
Subjects Wn. Groups Error (a)	725.515	140	5.182	—
B (Operations)	5585.310	2	2792.660	855.856*
AB	301.492	6	50.250	15.399*
B X Subjects Wn. Groups (Error b)	913.862	280	3.263	—
C (Materials)	528.699	2	264.350	483.272*
AC	116.751	6	19.460	35.575*
C X Subjects Wn. Groups (Error c)	153.217	280	0.547	—
BC	50.630	4	12.660	20.754*
ABC	47.772	12	3.980	6 524*
BC X Subjects Wn. Groups Error (bc)	341.601	560	0.610	—
Total	9928.160	1295		

*Significant beyond .01 level.

TABLE—20 Analysis of Variance of the Scores of Girls with Repeated Measures on Operations (Discrimination, Seriation and Numeration) and Materials (Blocks, Slats and Sticks) at the Four Age Levels for the *School Going Group* for Series I.

Source of Variation	Sum of Squares	df	Mean sum of Squares	f
A (Age)	1096 256	3	365 420	116 043*
Subjects Wn. Groups Error (a)	440 926	140	3.149	—
B (Operations)	1026 839	2	513.420	296.946*
AB	414.939	6	69 160	40 000*

B X Subjects Wn. Groups Error (b)	484.219	280	1.729	—
C (Materials)	152.788	2	76.390	159.811*
AC	76.619	6	12.770	26.715*
C X Subjects Wn. Groups Error (c)	133.926	280	0.478	—
BC	42.541	4	10.640	25.333*
ABC	36 533	12	3.040	7.238*
BC X Subjects Wn. Groups Error (bc)	235.260	560	0.420	—
Total	4140.846	1295		

*Significant beyond 0.1 level.

TABLE—21 Analysis of Variance of the Scores of Girls with Repeated Measures on Operations (Discrimination, Seriation and Numeration) and Materials (Blocks. Slats and Sticks) at the Four Age Levels for the *Non School Going Group* for Series I.

Source of Variation	Sum of Squares	df	Mean sum of Squares	F
A (Age)	1276.446	3	425.480	91.383*
Subjects Wn. Groups Error (a)	651.886	140	4.656	-
B (Operations)	7435.446	2	3717.720	1690 641*
AB	423.450	6	70.580	32.096*
B X Subjects Wn. Groups Error (b)	615.997	280	2.199	-
C (Materials)	414.074	2	207.050	371.723*
AC	53.135	6	8 860	15.906*
C X Subjects Wn. Groups Error (c)	155.994	280	0.557	-
BC	57.091	4	14.270	38.053*
ABC	104.920	12	8.740	23.306*
BC X Subjects Wn. Groups Error (bc)	210.096	560	0.375	-
Total	11398.555	1295		

*Significant beyond .01 level.

TABLE — 22 Analysis of Variance of the Scores of Boys with Repeated Measures on Operations (Discrimination, Seriation and Numeration) and Materials (Blocks, Slats and Sticks) at the Four Age Levels for the *School Going Group* for Series II.

Source of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Age)	862.753	3	287.584	58 678*
Subjects Wn. Groups Error (a)	686.161	140	4.901	–
B (Operations)	264.266	2	132.133	52.153*
AB	320.969	6	53.494	20.790*
B X Subjects Wn. Groups Error (b)	720.543	280	2.573	–
C (Materials)	34.279	2	17.139	72.622*
AC	27.234	6	4.539	19.233*
C X Subjects Wn. Groups Error (c)	66.265	280	0.236	–
BC	9.049	4	2.262	6.575*
ABC	26.142	12	2.178	4.331*
BC X Subjects Wn. Groups Error (bc)	193.025	560	0 344	–
Total	3210.686	1295		

*Significant beyond .01 level.

TABLE — 23 Analysis of Variance of the Scores of Boys with Repeated Measures on Operations (Discrimination, Seriation and Numeration) and Materials (Blocks, Slats and Sticks) at the Four Age Levels for the *Non School Going Group* for Series II.

Source of Pariation	Sum of Squares	df	Mean Sum of Squares	F
A (Age)	1017.487	3	339.162	230.879*
Subjects Wn. Groups Error (a)	205.723	140	1.469	–
B (Operations)	7547.950	2	3773.975	1110.972*

AB	380.680	6	63.446	18 677*
BX Subjects Wn. Groups Error (b)	951.370	280	3.397	–
C (Materials)	305.821	2	152 910	161.980*
AC	61.661	6	10.276	10.885*
CX Subjects Wn Groups Error (c)	264 518	280	0.944	–
BC	72.216	4	18.051	68.646*
ABC	100.450	12	8.370	31.825*
BCXSubjects Wn. Groups Error (bc)	147.334	560	0.263	–
Total	11055.210	1295		

*Significant beyond 0.01 level

TABLE—24 Analysis of Variance of the Scores of Girls with Repeated Measures on Operations (Discrimination, Seriation and Numeration) and Materials (Blocks, Slats and Sticks) at the Four Age Levels for the *School Going Group* for Series II.

Source of Variation	Sum of Squares	df	Mean sum of Squares	F
A (Age)	549 796	3	183.265	62 441‡
Subjects Ws. Groups Error (a)	410.895	140	2.935	—
B (Operations)	166 617	2	83.308	44.789‡
AB	163.704	6	27.284	14.668‡
B × Subjects Ws. Groups Error (b)	520.790	280	1.860	—
C (Materials)	39.862	2	19.931	81.026‡
AC	18.940	6	3.156	12.829‡
C × Subjects Ws. Groups Error (c)	68.976	280	0.246	—
BC	5.337	4	1.334	7.329‡
ABC	11.824	12	0.985	5.412‡

BC × Subjects Wn. Groups Error (bc)	102.397	560	0.182	
Total	2059.138	1295		

‡Significant beyond .01 level.

TABLE—25 Analysis of Variance of the Scores of Girls with Repeated Measures on Operations (Discrimination, Seriation and Numeration) and Materials (Blocks, Slats and Sticks) at the Four Age Levels for the *Non-School Going Group* for Series II.

Source of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Age)	1156.377	3	385.459	144.096‡
Subjects Wn. Groups	374.567	140	2.575	—
B (Operations)	8393.229	2	4196.611	1511.204‡
AB	513.993	6	85.665	30.848‡
B × Subjects Wn. Groups Error (b)	777.668	280	2.777	—
C (Materials)	254.178	2	127.089	260.428‡
AC	31.377	6	5.229	10.715‡
C × Subjects Wn. Groups Error (c)	136.675	280	0.488	—
BC	42.322	4	10.580	23.936‡
ABC	74.142	12	6.178	13.977‡
BC × Subjects Wn. Groups Error (bc)	247.976	560	0.442	—
Total	12002.507	1295		

‡Significant beyond .01 level.

Since the study involved repeated measures of Age × operations × materials factorial experiment in which there were repeated observations on the last two factors, an appropriate model of statistical analysis was employed (Winer, B.J., 2nd Ed., 1971, pp. 539–550). As this design was of a mixed model type with the subjects randomly assigned to different experimental conditions the model of analysis suggested under case I type of analysis by Winer, 1971 was employed. First, the existence of significant interactions with subjects was sought to be tested. The test for homogeneity of interactions with subjects was made for the data for school going boys for series I and since the data for the other groups was obtained under similar experimental conditions employing the same design of the study it was assumed that the same results would be expected to be obtained. The observed X^2 value exceeded the critical value for a test with 20 the test indicated that the interactions should not be pooled. However, the interactions with subjects have to be considered for their significance on their own.

Thus, tests on Operations (B) and Age × Operations (A × B) use MS error (b) as denominator for F ratios. Materials (C) and Age × Materials (AC) use Ms error (C) as denominator. Tests on Operations × Materials (B × C) and Age × Operations × Materials use Ms error (BC) as denominator. The main effect of Age (A) was tested with MS error (a).

It would be seen from Table 18 that the main effects for factors A (Age), B (Operations) and C (Materials) were found to be statistically significant. For effect A, we have F = 551.346/3.666 with 3 and 140 df. Because the four means of age groups A_1, A_2, A_3 and A_4 have been averaged over the trials, they correspond to a general overall measure of performance for each age group. The test of significance indicates that the measures of performance for the operations and materials differ significantly. For the B effect i.e., operations, the F value = 240.963/1 609 for 2 and 280 df. Inspection of the totals for operations B_1, B_2, and B_3, (discrimination, seriation and numeration) indicated decreasing size of scores for the three operations in a decreasing order. The F ratio 100:889/1.609 for 6 and 280 degrees of freedom for A×B interaction was also noted to be statistically significant. A significant A×B mean square would mean that the performance of the four age groups on the three operations were not of the same form. This is in keeping with our theory that children at different age levels perform differently on the three operations of discrimination, seriation and numeration.

The scores for both boys and girls increased with age Thus, age and performance of the operations of discrimination, seriation and numeration were interrelated. At the 4 year age level children were able to discriminate successfully between the array of stimuli presented to them. But at the same age level the subjects committed number of errors in the scriating operation. However, by the time they reached the 6 year age level children were able to perform seriation as efficiently as they could discriminate. They were, however, unable to be as deft with the numeration task. At the 7 year age level they were still unable to perform the numeration task flawlessly. This suggests that the three operations discrimination, seriation and numeration were mastered at different age levels and this is a very important finding that corroborates Piaget's findings on the development of the number concept among the young children.

The F value for C (Materials) equals 83.922/0.430 for 2 and 280 degree of freedom. The inspection of the totals for meterials C_1, C_2 and C_3 i.e., blocks, slats and sticks indicated that the scores were progressively lower in a decreasing order from three dimensional, through two dimensional to unidimensional. Subjects committed most of the errors with C_3 i.e., unidimensional materials (sticks). For the interaction A×C, F equals 19.178/0.430 for 6 and 280 degrees of freedom, significant beyond the .01 level. This suggests that subjects at the four age levels performed differently with the three types of materials C_1, C_2 and C_3. In other words, the availability of more perceptual cues makes the problem of performance of the operations easy. That is, young children were able to discriminate between the different sized blocks more easily than between the different sized slats. Similarly, they were able to discriminate between the different sized slats more easily than between the different sized sticks. This explains the significant interaction effect of B×C (Operations×Materials). The significant interaction of A×C (Age×Materials) perhaps, explains the importance of dimensionality, as perceptual cues, for children of different age levels A young child may not discriminate between to objects owing to his non-perception of certain cues Young children are more distractable and are less attentive They are not able to hold their attention beyond a brief span. Thus, when a three dimensional object was presented they found it easy to discriminate of differentiate because there were more perceptual cues. As children grow in age they are able to attend to more details. Thus, a child who failed to discriminate between two sticks slightly varying in length was able to successfully do so when he was older. Our results point to the conclusion that the dimensionality of materials have an important bearing on the perceptibility of the cues by the subjects.

The interaction of Age × Operations × Materials was also significant for all the groups suggesting that the younger children's capacity to perform the operations was affected by the dimensionality of the materials. Younger children were able to perform well when more perceptual cues were available i.e., they performed successfully with blocks but not with other materials like slats and sticks. The older children were able to perform all the operations easily with materials such as sticks which offered fewer perceptual cues owing to their unidimensionality.

Tables 19, 20 and 21 present the data for the other groups similar to the data obtained in Table 18 for the boys with Series I and the results show that boys - school going or non - school going, girls - school going or non - school going, have performed alike. Within the school going group of boys or girls the differences were comparable.

The results obtained with series II i.e., a second set of materials corroborate the results obtained in series I (with the first set of materials). Tables 22, 23. 24 and 25 present the data. All the results presented in Tables 18 to 25 indicate that there were significant differences between the subjects of the four age groups A_1, A_2, A_3 and A_4 with regard to their performance on the three operations discrimination, seriation and numeration with the three materials blocks, slats and sticks.

The detailed analysis made in this part of the investigation corroborates the results presented in Tables 3 to 6.

The hypotheses formulated for this study have been retained as warranted on the basis of obtained results. Children belonging to different age levels perform differentially on the three operations discrimination, seriation and numeration. The younger children would have attained the necessary cognitive structures to enable them perform simple operations involved in discrimination but they may not have attained the necessary structures to enable them perform successfully with the other operations which are more complex in comparison to discrimination. The older children were able to perform these operations with ease as they would have attained the necessary structures owing to their age and richer or wider experience leading to assimilation - accommodation resulting in the development of more inclusive schemata.

The design of the present investigation involved repeated measures of the same subjects for operations with different materials. In the studies of learning, such a design usually is expected to yield results pointing to improvement or change of performance as an outcome of practice (repeated trials). The obtained results in this investigation belied this expectation. For, though the design was of the type of repeated measures of the same subjects, the task was not of the type of a learning task. According to Piaget, cognitive development does not take place as a result of mere practice. Cognitive development is age related in that a younger child would not be able to do what an older child can as the necessary cognitive structures would not have been attained. An older child would be able to perform all the tasks that his younger counterpart can, because of the presence of the necessary cognitive structures. This suggests that age is an important factor in the attainment of the cognitive structures. This does not, however, mean that cognitive development is determined by maturation. Piaget does not believe that the cognitive structures grow as a function of physical growth. This view is not considered tenable because mere growth without the necessary experience is fruitless.

The results obtained in this study, strongly suggest an interactionist point of view. There were significant differences between school going pupils and subjects without any schooling. Piaget explains that cognitive structures grow as a result of accommodation – assimilation processes. Central to this theory is the postulate that motor action is the source from which all mental operations emerge. The motor action is basic to the acquisition of the cognitive operation. Cognitive activities progressively replace overt motor behaviour. In this process the responses are modified. The subject experiences and reacts to the environment in terms of an existing cognitive structure or organization. The organization is constantly changing owing to the assimilation of new materials and accommodation to new stimulations. Assimilation of new material into an existing schema modifies it, and whatever is assimilated into a schema is aliment for that schema. Aliment is not an object but rather those properties of the object which are assimilated and accommodated to.

The three operations discrimination, seriation and numeration are not extensions of the first. By means of training or practice on the first there would be no improvement as a logical necessity in the performance of the other operations. Similarly training on the second (seriation) would not help improve performance on the third (numeration). In a sense, the operations were discretely arranged in a hierarchical order. The higher operation in the order includes the structures of the stage immediately proceeding it. Therefore, repeated measures did not show any improvement in performance as a result of practice. The trend of the scores was obuiously downward indicating that the three operations serially made were of increasing difficulty or even of different nature.

The same explanation appears warranted for the results obtained with repeated measures using different kinds of materials. Here, the task remained the same for the subject. The subject was required to discriminate or seriate or numerate, as the case may be, but each time withe different materials. Once again, there was no discernible practice effect.

There were differences in the materials which were crucial to the performance of the operations. The differences consisted in the dimensionality of the materials which provided different perceptual cues to the subjects. The obtained significant F ratios for B (operations) and C (materials do not suggest differences owing to practice effects but differences owing to perceptual cues. The interaction effects A X B, A X C, B X C and A X B X C indicate that the differences were a product of the differential effects of the variables taken together.

Conservation

To test the hypothesis that, conservation of number would not be ralated to the operations of discrimination, seriation and numeration, the subjects from all the sub-groups were all tested for conservation of number at the commencement of the investigation, i e , prior to administering any discrimination, seriation and numeration tests. There were no non-conservers at the 7 year age level. Practically every subject at this age level could conserve number without much difficulty. On the other hand, subjects at the 4 year level were not able to conserve. Only a very small number among them could conserve. There were marked differences in conserving ability at the 5 and 6 year levels.

The conservation tests employed comprised the following tests : Two heaps of plastic chips were placed before the subjects. The chips were of different colours but were all of same shape and size. In the first test the heaps contained 4 chips each. Subjects were shown that both the heaps had equal number of chips. Next the chips in one of the heaps were arranged in a straight line. Subjects were asked to judge whether the number in two was the same. Tests two, three and four employed progressively more chips. The procedure employed in the first four tests was essentially the same. The chips in one heap were not arranged in any design or pattern but the chips in the other heap were arranged in a particular design. The design was lengthened or shortened and subjects were asked to judge wheather the number was more or less or same. In the fifth test the chips were arranged in two lines at the outset but their shape was progressively changed without either adding or taking away any from either of the heaps. The 4 year old children could not conserve while the 7 year old children had no difficulty in conserving.

On the basis of the scores obtained by the subjects, two extreme groups of subjects securing high and low conservation scores were identified and selected. The discrimination seriation and numeration scores of the two contrasting groups of subjects were compared. Table 26 presents the mean difference of the high and low conserving subjects on discrimination, seriation and numeration tests at each age level. It would be seen from the table that with regard to discrimination performance, the two groups (high and low conserving) did not significantly differ. However, the same groups differed with regard to their seriation and numeration performance at all the age levels.

From Table 26 it would be seen that at all the four age levels, 4 through 7 years, subjects with high number conservation scores did not differ from subjects with low conservation scores with regard to discrimination scores. In other words, subjects from the two groups made almost similar discrimination scores. But the subjects differed significantly with regard to seriation and numeration scores.

TABLE 26 — Mean Differences Between High and Low Conservation Scores and 't' Values on Discrimination, Seriation and Numeration Tests agewise.

			DISCRIMINATION				SERIATION				NUMERATION	
Age	N	df	Difference Between Means	't' Value	N	df	Difference Between Means	't' Value	N	df	Difference Between Means	't' Value
4 H–C	25	24	1.12	0.89	25	24	10.08	14.52**	25	24	10.96	21.32**
L–C	25	24			25	24			25	24		
5 H–C	25	24	1.84	1.41	25	24	3.48	3.09**	25	24	4.00	4.16**
L–C	25	24			25	24			25	24		
6 H–C	25	24	0.16	0.11	25	24	6.04	4.77**	25	24	8 64	7.19**
L–C	25	24			25	24			25	24		
7 H–C	25	24	—	—	25	24	4.72	3.68**	25	24	5.60	4.45**
L–C	25	24			25	24			25	24		

**Significant beyond 0.01 level.

When the subjects were divided interms of discrimination scores it was found that their number conservation scores significantly differed at both the 4 and 5 year age levels. This suggests that by the time conservation of number was attained by the subjects they were also able to discriminate. From Table 27 it would be seen that when subjects were differentiated into high and low scorers on the basis of their discrimination scores, they significantly differed with regard to their conservation scores at the 4 and 5 year age levels. The results were not significant at the 6 and the 7 year age levels. This suggests that the ability of number conservation cannot be assumed on the basis of the discrimination scores.

Numerosity :

The subjects from all the sub-groups were administered, in addition to conservation of number tests, a numerosity test. The numerosity tests employed were all simple and required judgment of more or less in comparison with a standard. Two heaps of chips were placed before the subject and the subject was invited to judge whether the heap on the right had more chips or less chips or same number of chips as the heap on the left. There were 5 tests and in each test, the subject was randomly asked to judge the right heap or left heap which contained 3, 5, 7, 9 and 11 chips each.

TABLE 27 — Mean Differences Between High and Low Discrimination, Seriation and Numeration Scores and 't' Values on Conservation Test agewise.

				DISCRIMINATION				SERIATION				NUMERATION	
Age		N	df	Difference Between Means	't' Value	N	df	Difference Between	't' Value	N	df	Difference Between	't' Value
4	H	25	24	0.88	4.88**	H 25	24	1.56	8.66**	H 25	24	1.12	6,29**
	L	25	24			L 25	24			L 25	24		
5	H	25	24	8,24	10.73**	H 25	24	6.84	9.37**	H 25	24	7.96	10.73**
	L	25	24			L 25	24			L 25	24		
6	H	25	24	1.48	1 08	H 25	24	3,52	2.58**	H 25	24	4.12	3.14**
	L	25	24			L 25	24			L 25	24		
7	H	25	24	—	—	H 25	24	—	—	H 25	24	—	—
	L	25	24			L 25	24			L 25	24		

**Significant beyond 0.01 level. H = High. L = Low

Table 28 shows mean differences of scores on dircrimination, seriation and numeration tests of high and low scoring groups. With regard to discrimination tests the high and low scoring groups on numerosity did not significantly differ at any age level 4 through 7 years. The scores for seriation and numeration were all significant at the .01 level for all the groups 4 through 7 years. This would appear to suggest that by the 4 year age level the subjects have acquired the ability to differentiate more from less. They were able to discriminate between more and less. The high and low scoring subjects withe numerosity tests significantly differed with regard to seriation and numeration scores at all the age levels 4 through 7 years. This finding suggests that the subjects who are able to judge numerosity could also seriate and numerate.

In Table 29 the mean differences of scores on numerosity tests for high and low scoring subjects on discrimination, seriation and numeration tests are presented. It would be seen that at the 4 and 5 year age levels the differences were all significant. This suggests that around the 6 year age level subjects were able to judge numerosity reasonably well. Table 29 suggests that at 7 year age level there were no significant differences between subjects on numerosity scores.

TABLE 28 — Mean Difference Between High and Low Numerosity Scores and 't' Values on Discrimination, Seriation and Numeration Tests Age-wide

Age		N	df	DISCRIMINATION Difference Between Means	't' Value	N	df	SERIATION Difference Between Means	't' Value	N	df	NUMERATION Difference Between Means	't' Value
4	H–N	25	24	1.36	1.09	25	24	8.96	12.25**	25	24	11.68	22.46**
	L–N	25	24			25	24			25	24		
5	H–N	25	24	1.76	1.05	25	24	3.84	3.48**	25	24	5.48	5.63**
	L–N	25	24			25	24			25	24		
6	H–N	25	24	0.06	0.08	25	24	6.08	4.84**	25	24	9.08	7.61**
	L–N	25	24			25	24			25	24		
7	H–N	25	24	—	—	25	24	5.08	3 99**	25	24	6.20	5.34**
	L–N	25	24			25	24			25	24		

** Significant beyond .01 level. H = High, L = Low

TABLE 29 — Mean Differences Between High and Low Discrimination, Seriation and Numeration Scores and 't' Values on Numerosity Test.

Age		N	df	DISCRIMINATION Differences Between Means	't' Value		N	df	SERIATION Differences Between Means	't' Value		N	df	NUMERATION Differences Between Means	't' Value
4	H-D	25	24	0.32	3.20‡‡	H-S	25	24	0.96	12.00‡‡	H-N	25	24	0.80	7.54‡‡
	L-D	25	24			L-S	25	24			L-N	25	24		
5	H-D	25	24	8.04	12.10‡‡	H-S	25	24	7.84	11.95‡‡	H-N	25	24	8.68	13.11‡‡
	L-D	25	24			L-S	25	24			L-N	25	24		
6	H-D	25	24	1.96	1 45	H-S	25	24	4.80	3.73‡‡	H-N	25	24	5.48	4 29‡‡
	L-D	25	24			L-S	25	24			L-N	25	24		
7	H-D	25	24	—	—	H-S	25	24	0.32	0.23	H-N	25	25	0.32	0.23
	L-D	25	24			L-S	25	24			L-N	25	24		

‡‡ Significant beyond .01 level. H = High, L = Low

In the face of the results obtained as above the hypothesis that numerosity scores would be unrelated to discrimination, seriation and numeration operations was rejected as untenable. The hypothesis has to be retained for the subjects of the 7 year age group. At this age level all subjects were able to pass the numerosity tests. There were no differences in scores between subjects' numerosity tests.

Schooling/No Schooling :

One of the important variables of this study wss schooling. The subjects of this investigation comprised those who attended schools and those who did not go to any school. The subjects selected as above (see sampling procedures and variables) were administered the discrimination, seriation and numeration tests.

Table 12 presents difference between means of discrimination scores of school going and non-school going subjects age- and sex-wise. Tables 13 and 14 present the data for seriation and numeration tests.

Piaget, as said elsewhere, is Lukewarm to the idea that environmental factors mould cognitive structures. He is also averse to the notion that maturation in itself is sufficient to explain mental development. The results examined in this part of our study exemplify the accommodation-assimilation principle of Piaget. Children who are fortunate to be able to go to school are exposed to stimulations which require modification of the "schema" In this process, certain amount of assimilation of, and accommodation to, the environment becomes possible as well as necessary. Children who do not go to schools have obviously no stimulations which necessitate modification of acquired cognitive structures. Thus, in this regard there is no possibility and even necessity for change in cognitive structures through assimilation - accommodation process. The results presented in Tables 12, 13 and 14 show that schooling plays significant part in cognitive development in general, and in the development of number concept in particular. Therefore, the null hypothesis that schooling or absence of schooling would not be significantly related to differences in the operations of discrimination, seriation and numeration was rejected as unwarranted.

Mental Ability :

In order to examine the relation of mental ability to discrimination, seriation and numeration operations, subjects were administered a "Draw-a-man" test (Phatak, 1966) during the last session of the testing programme. Ignoring sex differences, the subjects' performance was studied in relation to the mental ability scores. On the basis of the scores obtained by the subjects at each age level the high and low scoring groups were differentiated. The scores obtained by the high and low groups were examined. Tables 30, 31, 32, and 33 present the analysis of variance of the data.

TABLE 30 — Analysis of Variance of Scores on Discrimination, Seriation and Numeration Operations at the Four Age Levels for High and Low Mental Ability Groups from the School Going Group for Series I.

Source of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Ability)	51.74	1	51.74	36 43††
B (Tests)	1009.53	2	504.75	107.624††
C (Ages)	1981.88	3	660.62	65.214††
A×B	9.39	2	4 69	3.30††
A×C	30.43	3	10.13	7.13††
B×C	619.80	6	103.30	132.43††
A×B×C	4.67	6	0.78	—
Error	2427.57	1704	1.42	—
Total	6134.91	1727	—	—

†† Significant beyond .01 level; † Significant beyond. 0.05level.

TABLE 31 : Analysis of Variance of Scores on Discrimination, Seriation and Numeration Operations at the Four Age Levels for High and Low Mental Ability Groups from the Non-School Going for Series–I.

Source of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Ability)	1.69	1	1.69	—
B (Tests)	8868.32	2	4434.16	3924.035‡
C (Ages)	1256.53	3	418.84	80.237‡
A×B	2.26	2	1.13	—
A×C	15.67	3	5.22	2.36
B×C	354.15	6	59.02	18.559‡
A×B×C	19.13	6	3.18	1.43
Error	3766.81	1704	2.21	
Total	14284.56	1727		

‡ Significant beyond .01 level.

TABLE 32 : Analysis of Variance of Scores on Discrimination, Seriation and Numeration Operations at the Four Age Levels for High and Low Mental Ability Groups from the School Going Groups for Series–II.

Sources of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Ability)	54.55	1	54.55	45.84†
B (Tests)	1292.61	2	646.31	55.81†
C (Ages)	2008.55	3	669.52	30.64†
A×B	23.17	2	11.58	9.73†
A×C	65.57	3	21.85	18.36†
B×C	335.81	6	55.96	14.84†
A×B×C	22.63	6	3.77	3.16†
Error	2028.34	1704	1.9	
Total	5831.23	1727		

†Significant beyond .01 level.

TABLE : 33 Analysis of Variance of Scores on Discrimination, Seriation and Numeration Operations at the Four Age Levels for High and Low Mental Ability Groups from the Non-School Going Group for Series-II.

Source of Variation	Sum of Squares	df	Mean Sum of Squares	F
A (Ability)	0.30	1	0.30	—
B (Tests)	10441.09	2	5220.54	2231.00†
C (Ages)	1234.06	3	411.35	133.990†
A×B	4.69	2	2.34	1.46
A×C	9.23	3	3.07	1.91
B×C	469.37	6	78.22	38.722†
A×B×C	12.15	6	2.02	1.26
Error	2741.07	1704	1.60	
Total	14911.96	1727		

† Significant beyond .01 level.

It would be seen that the F ratios for both the series of data were significant suggesting that the more able subjects were able to perform better than the less able subjects with regard to the operations of discrimination, seriation and numeration. As the obtained F ratios were significant the data were analysed further to examine in depth the significance of the differences.

It would be seen that the means for the 4 year schooling, group alone were significantly different for both the series. The means for the 5 year schooling group were also significant at the .05 level in the series II. The 't' values for the non-schooling groups in both the series were not significant.

It was seen earlier that children were able to discriminate by the time they reached the 5 year level. Most children were able to perform the discrimination tasks successfully even at the 4 year level. At the 6 or 7 year age levels, they did not show any differences among themselves in discrimination performance owing to the fact that this skill has already been attained. Schooling or non-schooling did not appear to make much difference in this regard. Similarly, the ability levels also did not appear to affect the nature of the results. This could easily be explained as having been owing to the attainment of the ability at or around 4 years of age. The results obtained in this study suggest that the superior children could profit from schooling at the lower age levels. The older children were able to discriminate irrespective of whether they had any schooling or not, or whether they differed with regard to ability levels or not. As they performed alike, the 't' values naturally were not significant. The data for seriation presented a little different picture. The obtained 't' values for the 4 year level for both the schooling and non-schooling groups, in both the series I and series II were not significant

The scores for the school going groups at the 4 year level were in the range of 15.20 to 16.05 and for the non-school going groups the scores ranged from 9.70 to 11.14 suggesting that children at 4 year level from each category (schooling and non-schooling) performed largely alike. Ability differences do not seem to have much effect at this age level (4 year). However, the school going groups performed significantly better than the non-schooling going groups. In the early acquisition of seriation the experiences and stimulations provided by the schools seem to have a positive influence.

The 't' values for the 5 and the 6 year age levels for all the sub-groups of subjects schooling/non-schooling and high ability/ low ability were all significant. Our results showed that children were able to seriate tolerably well by the time they reached the 6 year level and at the 7 year level all subjects were able to seriate successfully. This explains the nature of the results obtained. The children with higher levels of ability were able to take advantage of the learning experiences provided to them at the school or outside the school. The non-school going children performed at a much lower level than the school going children. But the advantage, if any, enjoyed by the school going children become ineffective, at the 7 year level, perhaps owing to the fact that at this age level children would have had the necessary maturation that helped acquisition of the cognitive structures involved in seriation. The obtained 't' values for all the sub-groups at the 7 year level were not significant because they performed almost alike.

With regard to numeration, the obtained results presented a slightly different picture. The 't' values for the 4 and the 5 year age level subjects were not significant. This was owing to their scoring very low at the 4 and the 5 year levels. Our results discussed elsewhere showed that discrimination was usually attained by the age of 4, seriation by the a ge of 6, and that numeration was not fully attained by the age of 7 years.

The mean scores show that at the 4 year age level the numeration scores were as low as 8.83 for the school going subjects and the scores for the non-school going subjects were much lower at 2.16. This convincingly suggests that at the 4 year level children would not have acquired the numeration ability. This should not be construed to mean that children were not able to use numbers. As a matter of fact, several children were found to use the numbers, but it was only in the nominal sense. For them a number word was like any other word. The means show that the school going children performed better than their non-school going counterparts. The children owing to their learning at school may have acquired the use of number in its ordinal form. Even here we find that children with higher or lower ability did perform in a markedly different way. The obtained 't' values were all non-significant. The same situation persisted at the 5 year age level also. No obtained 't' values were significant. There was, ofcourse, a marked improvement in the scores of school going children. But there were no significant differences owing to the differences in ability levels. At the 6 year level the 't' values for the school going subjects were found to be different suggesting that the children with superior ability were able to take advantage of the learning experiences to which they were exposed at school. The mean scores obtained by them were higher. The non-school going groups tended to score low even at the 6 year level. The position does not seem to have altered very much at the 7 year level. The superior school going groups made the highest possible scores at the 7 year level. Even so, the subjects with lower ability did not lag far behind. They performed at a much higher level than the non-school going subjects.

This suggests that ability is a very important factor in the acquisition of cognitive structures. Mehryan and Sabharwal (1972) reported positive correlation between measures of intelligence and Piagetian tasks. The results were interpreted as an indication of a general factor common to Piaget's tasks and traditional tests of intelligence. If this were to be true, subjects with higher scores in intelligence should be found making higher scores on conservation problems (Rao, 1976). Our results while corroborating the above help better appreciation of cognitive development. Ability it would be seen plays a significant role when the necessary stimulations and experiences are made available for the growth of the cognitive structures. With tasks like discrimination, differences in ability levels do not seem to play a marked role. But with regard to higher skills like seriation and numeration, differences in ability appear to have differential effects. The results warrant rejection of the null hypothesis that ability levels would not be significantly related to the discrimination, seriation and numeration functions. This rejection could be made conditional and we may conclude that ability levels play significant role in the acquisition of more complex or higher cognitive functions. Ability differences appear to play less significant part in the acquisition of simpler cognitive functions like discrimination. There could be another reason why either ability or schooling differences affect discrimination ability insignificantly. This could be owing to the importance of perceptual cues in discrimination. Subjects who are able to perceive well should be able to discover the cues and discriminate accordingly. In this, maturational factors obviously play an important role. With seriation and numeration, the picture gets somewhat different. Perceptual factors could be understood to play a less important role. Naturally, ability levels assume greater importance in higher or complex cognitive functions. In this context, schooling assumes a great importance. Our results have unmistakably pointed this implication.

The obtained results show that the differences in ability are perhaps related to differences in the performance of basic operations underlying the acquisition of the number concepts. The interaction between ability (A) and operations (B) were significant for school going groups in both the series I and II. But for the non-school going groups the interaction between ability and operations were not significant in series I as well as in series II. This suggests that ability levels as assessed by the "Draw-a-man" test and the three basic operations discrimination, seriation and numeration in the development of number concept are perhaps unrelated for non-school going groups. The interaction between ability and age levels was significant for school going groups in series I and II. The interaction between ability and age levels was not significant for non-school going groups. The interaction between operations and age levels was significant for both schooling as well as non schooling groups in series I and II suggesting that age as representing growth of necessary structures through assimilation - accommodation as a consequence of exposure to wider and larger number of stimulations is understandable. The hypothesis that there would be no significant relation between ability and concept development was rejected for school going groups. The hypothesis was retained for non-schooling groups with the modification that it could be tenable only at the higher age levels namely 6 and 7 years.

Scalogram Analysis

The data were further analysed employing scalogram analysis. Wohlwill (1960) suggest that cognitive development is best investigated longitudinally. However, most studies, for various practical reasons, have been cross-sectional in nature. Wohlwill suggests that the weakeness of this approach could be overcome by taking recourse to scalogram analysis. Accepting this suggestion, the data obtained in this investigation were subjected to scalogram analysis to trace development sequence. The analysis for the scores in the two series were made independently.

On the basis of the demonstrated scalability of tests it could be inferred that there was a single developmental process progressively moving in the direction of symbolic mediation (items 4, 8 and 12 of numeration tests). For the group of subjects varying in age from 4 to 7 years, it would be possible to construct a scalable set of items. The items thus ordered correspond to a hypothetical order of difficulty. This correspondence would seem to confirm the developmental sequence which emerged from the pattern of responses.

Order of Difficulty of Test Items

Table 34 presents the number of subjects passing each item of the discrimination, seriation and numeration tests. Table 35 presents the order of difficulty of the items in terms of the percentage of the subjects passing each item.

Table 36 to 41 present the critical ratios of differences between proportions of subjects passing each pair of items.

TABLE 34 — Number of Subjects passing each of the Items in Discrimination, Seriation and Numeration Tests (Total N for each = 288) and Rank Order of Items

Items	DISCRIMINATION								SERIATION								NUMERATION							
	S I		S II		S I		S II		S I		S II		S I		S II		S I		S II		S I		S II	
	Schooling		Schooling		Non-Schooling		Non-Schooling		Schooling		Schooling		Non-Schooling		Non-Schooling		Schooling		Schooling		Non-Schooling		Non-Schooling	
	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R
1	288	1	288	1	288	1	288	1	280	1	282	1	236	1	240	1	276	1	277	1	214	1	208	1
2	288	2	288	2	288	2	280	2	280	2	282	2	236	2	240	2	273	3	273	5	105	4	85	4
3	288	3	288	3	288	3	288	3	280	3	282	3	236	3	240	3	165	7	262	9	20	7	10	7
4	288	4	288	4	287	7	288	4	220	10	218	10	115	10	116	10	125	10	178	10	–	10	–	10
5	288	5	288	5	288	4	288	5	255	4	256	4	173	4	166	4	276	2	177	2	212	2	205	2
6	288	6	288	6	286	8	287	6	255	5	256	5	173	5	166	5	272	4	274	4	65	5	46	5
7	287	7	288	7	288	5	288	7	255	6	256	6	173	6	166	6	154	8	272	7	14	8	8	8
8	244	8	295	8	259	10	286	10	202	11	206	11	90	11	17	11	126	11	148	11	–	11	–	11
9	235	9	288	9	288	6	288	8	223	7	241	7	126	7	133	7	273	5	276	3	176	3	149	3
10	205	10	282	11	239	11	286	11	223	8	241	8	126	8	133	8	254	6	273	6	42	6	23	6
11	183	11	287	8	272	9	285	9	223	9	241	9	126	9	133	9	157	9	272	8	14	9	8	9
12	167	12	235	12	154	12	223	12	132	12	195	12	57	12	6	12	87	12	122	12	–	12	–	12

N = Number of Subjects S I = Series I; S II = Series II; R = Rank Order of Items

TABLE 35 — Percentage of Subjects passing each of the Items.

	DISCRIMINATION				SERIATION				NUMERATION			
	S I	S II	S I	S II	S I	S II	S I	S II	S I	S II	S I	S II
Items	Schooling	Schooling	Non-Schooling	Non-Schooling	Schooling	Schooling	Non-Schooling	Non-Schooling	Schooling	Schooling	Non-Schooling	Non-Schooling
1	100.00	100.00	100.00	100.00	97.22	97.91	81.94	83.33	95.83	96.18	74.30	72.22
2	100.00	100.00	100.00	100.00	97.22	97.91	81.94	83.33	94.79	94.79	36.45	29.51
3	100.00	100.00	100.00	100.00	97.22	97.91	81.94	83.33	57.29	90.97	6.94	3.47
4	100.00	100.00	99.65	100.00	76.36	75.69	39.93	40.27	43.40	61.80	—	—
5	100.00	100.00	100.00	100.00	88.54	88.88	60.06	57.63	95.83	96.18	73.61	71.18
6	100.00	100.00	99.30	99.65	88.54	88.88	60.06	57.63	94.44	95.13	22.56	15.67
7	99.65	100.00	100.00	100.00	88.54	88.88	60.06	57.63	55.20	94.44	4.86	2.77
8	84.72	98.96	93.40	99.30	70.13	71.52	31.25	5.90	43.75	51.38	—	—
9	81.59	100.00	100.00	100.00	77.43	83.33	43.75	46.18	94.79	95.83	61.11	51.73
10	71.18	97.91	82.98	99.30	77.43	83.16	43.75	46.18	88.19	94.79	14.58	7.99
11	98.26	99.65	94.44	98.96	77.43	83.68	43.75	46.18	54.51	94.44	4.86	2.77
12	57.98	81.59	53.47	77.43	45.83	67.70	19.79	2.08	30.20	42.26	—	—

S I = Series I S II = Series II

TABLE 36 — Critical Ratios of Differences between Proportions of Subjects passing each pair of items on Discrimination Test - Series I.

Items	12	10	8	11	6	7	9	5	4	3	2	1
12	—	9.19	15.98	16.19	17.43	18.00	18.07	18.07	18.07	18.07	18.07	18.07
10		—	8.03	8.26	10.61	10.87	11.10	11.10	11.10	11.10	11.10	11.10
8			—	0.309	3.94	4.55	4.88	4.88	4.88	4.88	4.88	4.88
11				—	3.71	4.28	4.62	4.62	4.62	4.62	4.62	4.62
6					—	1.00	1.74	1.74	1.74	1.74	1.74	1.74
7						—	1.02	1.02	1.02	1.02	1.02	1.02

df = 574;
Significant beyond the .05 level = 1.96;
Significant beyond the .01 level = 2.58.

TABLE 37 — Critical Ratios of Differences between Proportions of Subjects passing each pair of Items on Discrimination Test – Series II.

Items	12	10	11	8	6	9	7	5	4	3	2	1
12	—	5.69	9.06	9.06	9.51	9.69	9.69	9.69	9.69	9.69	9.69	9.69
10		—	4.43	4.43	5.17	5.48	5.48	5.48	5.48	5.48	5.48	5.48
11			—	4.43	1.13	2.06	2.06	2.06	2.06	2.06	2.06	2.06
8				—	1.33	2.06	2.06	2.06	2.06	2.06	2.06	2.06
6					—	1.00	1.00	1.00	1.00	1.00	1.00	1.00

df = 574;
Significant beyond the .05 level = 1.96:
Significant beyond the .01 level = 2.58.

The critical ratios for the three operations discrimination, seriation and numeration are shown independently for the two series. The items were numbered serially starting with blocks followed by slats and sticks. Items 1 to 5, 7 and 9 in discrimination were passed by all the subjects. Only items 6, 8 and 10 to 12 were not passed by all the subjects. The largest number of failures were with item 12 followed by items 10, 11 and 8. Comparison of item 6 with items 1 to 5, 7 and 9 did not yield significant C.Rs. (36 and 37), showing thereby that approximately same proportion of subjects passed the items concerned. The comparison of proportion of Ss passing item 8 with items 7 and 9 yielded a C.R significant beyond the 0.1 level, indicating that all subjects passing items 1 to 5, 7 and 9 may not have passed item 8. Comparison of item 11 with all items 1 to 9 yielded C Rs. significant at .01 level for all items. Comparison of item 10 with items 1 through 9 and 11 yielded C.Rs. all significant beyond the .01 level, indicating thereby that subjects passing the items 1 through 9 and 11 may not have all passed item 10. Similarly comparison of item 12 with items 1 to 11 yielded C.Rs. all significant beyond the .01 level suggesting that Ss passing items 1 to 11 may not have passed item 12.

The results obtained with series II were largely comparable to the above. However, comparison of item 11 with 8 yielded a value significant beyond the .01 level. The items 1 through 5, 7 and 9 were significant beyond the .05 level, but item 6 was not significant. The other results were comparable to those obtained in Table 42.

TABLE 38 — Critical Ratios of Differences between Proportions of Subjects passing each pair of Items on Seriation Test – Series I.

Items	12	8	4	11	10	9	7	6	5	3	2	1
12	—	3.13	5.65	10.58	11.27	13.05	14.98	15.53	16.08	19.25	19.25	19.45
8		—	2.55	7.58	8.28	10.10	12.14	12.72	13.24	16.62	16.62	16.83
4			—	5.08	5.80	7.66	9.79	10.39	10.90	14.51	14.51	14.71
11				—	0.73	2.65	2.29	2.71	3.27	10.06	10.06	10.27
10					—	1.91	4.15	4.80	5.38	9.40	9.45	9.66
9						—	2.24	2.90	3.51	7.71	7.71	7.93
7							—	0.75	1.27	5.65	5.65	5.78
6								—	0.61	5.02	5.02	5.25
5									—	4.43	4.43	4.67
3										—	0.07	0.27
2											—	0.26
1												—

df = 574;
Significant beyond the .05 level = 1.96;
Significant beyond the .01 level = 2.58.

TABLE 39 — Critical Ratios of Differences between Proportions of Subjects passing each pair of Items on Seriation Test – Series II.

Items	12	8	4	11	10	9	7	6	5	3	2	1
12	—	2.77	4.66	10.94	11.67	12.38	13.74	13.86	15.03	18.23	18.60	18.87
8		—	1.90	8.28	9.05	9.80	11.17	11.33	12.52	16 28	16.32	16.52
4			—	6.42	7.19	7.97	9.39	9.67	10.86	14.77	14.80	15.07
11				—	0.80	1.59	3.10	3.25	4.60	9.18	9.09	14.50
10					—	0.79	2.30	2.46	4 26	8.29	8.38	8.68
9						—	1.51	1.67	3.02	7.57	3.88	7.96
7							—	0.15	1.52	6.19	6.27	6.59
6								—	1.36	6.07	6.12	6.47
5									—	4.79	4.84	5.20
3										—	0.07	0.47
2											—	0.40
1												—

df = 574;
Significant beyond .05 level = 1.96;
Significant beyond .01 level = **2.58**.

TABLE 40 — Critical Ratios of Differences between Proportions of Subjects passing each pair of Items on Numeration — Test Series I.

	12	8	4	11	7	3	10	6	2	9	5	1
12	—	0.88	2.68	6.50	7.03	8.34	12.14	14.52	16.85	20.17	23.00	33.23
8		—	1.80	5.66	6.18	7.50	11.44	13.73	16.10	19.56	22.47	22.55
4			—	3.63	4.40	5.75	9.65	12.13	14.56	17.95	20.91	31.15
11				—	0.56	2.01	6.10	8.62	11.06	14.43	17.33	17.56
7					—	1.32	5.36	7.93	10.45	14.03	17.18	17.42
3						—	4.00	6.58	9.12	12.73	15.93	16.23
10							—	2.60	5.21	8.95	3.01	3.35
6								—	2.62	6.41	9.89	10.19
2									—	3.83	7.04	7.71
9										—	3.65	3.98
5											—	0.30
1												—

df = 574;

Significant beyond the .05 level = 1.96;

Significant beyond the .01 level = 2.58.

TABLE 41 — Critical Ratios of Differences between Proportions of Subjects passing each pair of Items on Numeration Test - Series II.

Items	12	8	4	7	11	3	10	6	2	9	5	1
12	—	1.19	2.72	8.22	8.43	8 83	8.95	10.24	12.45	16 32	19.76	20.12
8		—	1.53	7.07	7.28	7.68	7.80	9.13	11.34	15.26	18.76	19.12
4			—	5.58	5.77	6.19	6.29	7.64	9 89	13.89	17.45	17.74
7				—	0.20	0.63	0.73	2.09	4.43	8.59	12.39	12.75
11					—	0.41	0.53	1.89	4.22	0.37	12.22	12.57
3						—	0.11	1.48	3.81	7.97	11.82	12.10
10							—	1.36	3.70	7.85	11.70	12.10
6								—	2.33	6.54	10.44	10.80
2									—	4.24	7.03	8.61
9										—	4.10	0 32
5											—	0.38
1												—

df = 574;
Significant beyond the .05 level = 1.96
Significant beyond the .01 level = 2.58.

The items for seriation and numeration were examined as above. Tables 38 and 39 present the C.Rs. for seriation and tables 40 and 41 for numeration. It would be seen that the seriation items 1 to 3 were easy and were passed by most of the subjects whereas the other items were too difficult for the subjects to pass. Items 12, 8, 4, 11, 10, 9, 7, 6 and 5 were, in that order of difficulty, for the subjects; item 12 being the most difficult and item 5 being the least difficult. The results obtained for series II were consistent with the above.

In the same manner, the numeration items were found to vary in difficulty level tables 40 and 41 in the order as follows 12, 8, 4, 11, 7, 3, 10, 6, 2, and 9. Items 5 and 1 were least difficult and item 12 was most difficult. The results for series II were similar excepting for the reversal of the position of items 11 and 7.

The determination of the order of difficulty of these tests (items) does not answer the question: "Is there a predictable sequence in the order in which mastery of skills involved in these tasks develops, such that success on any task presupposes success on all prior sasks?" The scalogram analysis of the data was made to find a plausible answer for this question.

Guttman's original technique of scalogram analysis (Guttman, 1950) was criticized for the coefficient of reproducibility derived depends to a large extent on marginal totals of successes and failures for each item. Wohlwill (1960) suggested the use of a more satisfactory technique. White and Saltz (1957) in their discussion about the measurement of reproducibility suggested the use of Phi-coefficient. They hold that this statistic meets all the serious objections which have been levelled at Guttman's Scalogram analysis. They point that Jackson's Plus Percentage Ratio (PPR), Lovenger's Index of Homogeneity (H_t) and Green's Index of consistency (I) are all objective and result in measures which are not affected by the distribution of item difficulty. However, White and Saltz hold that the Phi-coefficient is the most satisfactory statistic because it has all the desirable characteristics in addition to having computational falicity. Lovenger's coeffieient of homogeneity (H_t) is the most conservative as it requires counting of all the possible errors;

and Jackson's Plus Percent (PPR) ratio is the least conservative. The Phi–coefficient is recommended because the significance level of the obtained statistic (Phi-coefficient) can be determined exactly. In view of the foregoing, Phi–coefficients were calculated for the items for the three tests discrimination, seriation and numeration. Tables 42 to 44 show the Phi–coefficients

On the discrimination test, children (subiects) of all age levels including the 4 year olds have passed items 1 to 8. There were differences in performance only on items 8 to 12. So there was no need for calculating Phi–coefficients for the items 1 to 7. Phi–coefficients were calculated for all the items on the seriation and numeration tests. The results were presented in Tables 42, 43 and 44: The procedure for computing the Phi-coefficients is described below.

Illustration of Computation of Phi-coefficients.

Item No· 12 – Discrimination – School Going Group Series I

	GROUP	
Low	High	A + B
11 (A)	159 (B)	170
118 (C)	0 (D)	118
129 (A + C)	159 (B + D)	288

$$\phi_{it} = \frac{BC - AD}{(A+B)\ (C+D)} = \frac{159 X 118 - 11 X 0}{170 X 118} = \frac{18762}{20060} = 0.93$$

TABLE 42 — Item Total Score Phi–Coefficients for Discrimination Test.

Items	SERIES I Schooling	SERIES II Schooling	SERIES I No Schooling	SERIES II No Schooling
8	.60	.33	.27	00
10	.92	.16	.095	.99
11	.23	00	.14	.91
12	.93	1.00	.047	.39

TABLE 43 – Item Total Score Phi-Coefficients for Seriation Test.

Items	SERIES I Schooling	SERIES II Schooling	SERIES I No Schooling	SERIES II No Schooling
1	.84	.86	.57	.59
2	.84	.86	57	.59
3	.34	.85	.48	.61
4	.61	.54	.77	.81
5	.87	.87	.84	.81
6	.87	.87	.84	.80
7	.84	.81	.54	.56
8	.56	.51	.73	.75
9	.86	.88	.92	.94
10	.86	.88	.92	.94
11	.85	.86	.62	.65
12	.47	.45	.64	.06φ

TABLE 44 — Item Total Score Phi-Coefficients for Numeration Test.

Items	SERIES I Schooling	SERIES II Schooling	SERIES I No Schooling	SERIES II No Schooling
1	.55	.98	.30	.23
2	.56	.99	.61	.56
3	.67	1.00	.82	.85
4	.78	.13	—	—
5	.57	.98	.30	.23
6	.59	.99	1.00	.99
7	.99	.94	.80	.85
8	.69	.11	—	—
9	.46	.98	.39	.19
10	.66	.99	.89	.91
11	1.00	1.00	.80	.85
12	.64	.51	—	—

The reproducibility indices assume that in a homogenous or a reproducible test the entire response pattern could be reproduced, given the total number of items that are passed and the item difficulties. All the methods construct a response matrix and agree that, in the response matrix of the perfectly reproducible test there will be no instances in which a subject passes an item more difficult than one he has failed. Conversely, the test with lowest reproducibility will exhibit zero inter-item co-variances and minimal variance in total scores. The items in the three operations were reorganized on the basis of difficulty levels and the response patterns for the subjects were examined on the basic premise that scalability of responses to aset of related problems is evidence for a single developmental continuum. In the formation of the number concept the following three stages could be discerned : i. An initial preconceptual stage in which the response is purely in perceptual terms without any symbolic medition. Our subjects have all passed the discrimination items presented with three dimensional materials (cubes). As the perceptual cues were reduced subjects encountered some difficulty in answering the items concerned. The discrimination items were passed by the 4 year old subjects and discrimination, is largely determined by perceptual cues. ii. This first stage is followed by an intermediary one in which the mediating structures representing the individual stimuli are developed, so that the perceptual cues necessary for differentiation is steadily reduced. iii. At the final stage, superordinate structures are elaborated leading to an understanding of such functional principles as conservation of number; and a little latter coordination between ordinal and cardinal number is attained. By determing the ordinal position of items we have obtained an ordinal scale of measurement. On the basis of the demonstrated scalability of the test items the growth of the number development is sought to be explained as a resultant of a developmental process involved in progressive increase in symbolic mediation (Wohlwill, 1960). The interpretation of the scale in terms of a developmental sequence assumes that (1) with increasing age a change in the direction of a higher scale type would take place; (2) it could be shown that children, at lower age levels were able to pass the items but fail the succeeding items which by implication are of higher order of difficulty; (3) an item passed by an older child may not be passed by a younger child but not vice versa, i.e., an older child would have reached a higher level of development (Welch, 1940; Welch and Long, 1940) and attained conceptualization corresponding to that operation and so would be able to perform operations involved in lower levels of conceptualization. The criterion frequently employed in developmental studies is the regularity and consistency with which specific behaviour patterns or responses occur is indicative of the maturational origin of it (Ames, 1937; Shirley, 1931; Long and Welch, 1941). However, for some reasons, a response or behaviour pattern may fail to appear in the case of a subject or subjects. It appears plausible that this could be owing to environmental factors. Behavioural patterns of psyohological nature are likely to be significantly affected by the environmental factors. In such instances as these, inference of maturational origin based on regularity and consistency of appearance of a behaviour could be highly misleading.

In this study the subjects belonged to two conditions namely those who attend school those who did not attend school. It is easy to appreciate that the two groups of subjects could be subject to differential stimulations. The variations that were observed in the subject's performance could have been the result of the environmental conditions (Martin, 1951). Our findings suggest that environmental influences can scarcely be ignored as factors in the development of the operations represented in our tests.

Table 34 presents the serial order in which the items were passed by the subjects from the different sub-groups. It would be seen that there are striking differences in the scores of the number of subjects passing a given test (item). Nevertheless, the relative ranking of the items remains largely undisturbed. The non-school going subjects have generally made markedly lower scores suggesting the late acquisition of the necessary cognitive skills for successful performance of seriation/numeration tasks. In so far as discrimination tests were concerned there were no differences between the two sub-groups, save performance with the last test namely item number 12. The significant number of failures on item 12 were perhaps owing to absence of sufficient dimensional cues. Most of the discrimination tasks were passed by all the sub-groups at the 4 year level.

This finding corroborates Piaget's and Elkind's findings. The seriation tasks did not present such a simple picture. The school going subjects tended to perform better while the non-school going subjects performed poorly. The seriation tasks appear to be mastered at the 6 year level. By the time the children reach the 7 year level they were able to master almost all items in the seriation tests. The numeration tests, in comparison with the preceding, appear to be more difficult. The differences in performance between the school going and the non-school going subjects was most marked. The 7 year old subjects from this group did not perform better than the 6 year old subjects from the school going group. The older non-school going subjects (7 year group) performed poorly on the numeration tasks compared to the 6 year old school going subjects. The major finding of this investigation supports the contention that rich and varied stimulations provided to children would help develop their assimilation--accommodation process, leading to the development of desired concepts.

QUALITATIVE ANALYSIS

Discrimination

The first and the second items concerned the capacity of the children to discriminate, to pick out the largest and the smallest element from a set of given elements. Most children ta the 4 year level exhibited little difficulty either in picking out the largest or the smallest item. Only five children encountered some difficulty in performing this task at this age level. The 3rd item consisted of disguising the element and requiring the children to pickout the smallest as desired. With this item also children had no difficulty. Between 80 to 90 percent of children experienced difficulty with item number 4 which consisted of disguising the largest element. Children were not able to pickout the largest in such a situation quickly. They often faltered.

From the performance of the subjects it could be easily seen that the discrimination function is largely perceptually determined. Even the 4 year old children did not err when they were presented with enough perceptual cues. That is, when they were dealing with blocks (three dimensiona material), there was no fumbling. When blocks were substituted by slats (two dimensional meterial) between 5 to 10 percent of the subjects committed errors which they could promptly be corrected on being shown the same. With sticks or one dimensional materials children experienced greatest amount of difficulty. Thus as the perceptual cues were reduced, discrimination performance was adversely affected.

Examination of the performance of subjects at progressively higher age levels viz., 5, 6 and 7 years showed that the errors rapidly decreased with increasing age and by the time the children reached the 6 year level no more than 5 percent of the subjects committed errors.

The results showed a striking difference in the performance of subjects who went to school and those who did not. The non-schooling group generally committed more errors. With increasing age, the differences tended to disappear rapidly. There were no differences in the discrimination performance between boys and girls. The two groups tended to be largely comparable with regard to discrimination.

This suggests that discrimination function is largely perceptually based and it is easiest when adequate perceptual cues are available. The younger children committed more errors, i.e., were not able to discriminate well perhaps owing to their inability to observe closely the available perceptual cues They were also not able to follow directions easily. The older children obviously were able to perform better as they were able to follow directions with ease.

Errors in discrimination consisted largely in the inability to make finer comparative judgments. It was observed that 3 children were confused with blocks, 8 with slats and 34 with sticks from the 4 year school going boys group in series I.

The non-school going boys group in this series (I) performed comparably, only one child confused with blocks, 12 with slats and 30 with sticks. The girls in this age group performed in a similar way. Three confused with blocks, 5 with slats, 33 with sticks from the school going group and 1 with blocks, 6 with slats and 33 with sticks from the non-school going group. The representative protocols given below would illustrate the situation.

School Going Subjects

1. Sreedhar - 4 Years.

Blocks - Showed the smallest and the largest elements quickly. On disguising the smallest was confused, could not identify it. Recognized the element on prompting. Showed the 8th block for the largest when the largest was disguised. Identified all the elements, i.e., the smallest and the largest on prompting.

Slats - Showed the smallest immediately. For the largest showed first the 2nd and then the 4th Slat. On asking to observe keenly and pickout the largest among all the 9 elements, he identified the largest. He showed the smallest quickly even after disguising it. But failed to identify the largest when it was disguised. For the largest he showed 2nd, 3rd, 5th and so on in a trial and error fashion instead of the 9th one. Even on prompting, he showhd the 8th one.

Sticks - Showed the smallest after observing the materials for some time. He exhibited alot of difficulty in identifying the largest item (9th). Showed different sticks instead of showing the 9th one. On prompting identified the largest. After disguising showed the smallest but failed to recognize the largest.

2. Hari Babu - 4 Years.

Blocks - Showed the smallest and the largest easily. When the elements were disguised, was not confused in identifying the smallest and the largest elements.

Slats - Showed the smallest quickly but was confused with the largest. On prompting identified the largest. On disguising the elements identified the smallest but failed to identify the largest. He picked up the 8th one for the largest.

Sticks - Identified the smallest easily. Was confused in picking up the largest. Showed the 6th one first and then the 8th one. Failed to identify the largest. Recognised the smallest on disguising but failed to show the largest.

1. Prasanna - 4 Years.

Blocks - She identified the smallest and the largest elements easily even when they were disguised.

Slats - Showed the smallest and the largest when asked to show. Identified the smallest easily when it was disguised. But for the largest she showed the 6th one. On prompting identified the largest.

Sticks - Showed the 2nd element for the smallest when asked to show the smallest. After asking her to observe the materials once again she identified the smallest. When asked to show the largest she picked up the largest after briefly surveying the elements. When the smallest was disguised she identified it easily. She identified the largest element with some prompting.

2. Manjula - 4 Years

Blocks - Recognized the smallest and the largest elements before and after they were disguised and was not confused.

Slats -- Showed the smallest quickly, but was confused in showing the largest and picked up the 8th one. On prompting identified the largest. Identified the smallest when disguised but failed to identify the largest. Showed the 7th one (for the 9th one).

Sticks - Was confused in recognizing the smallest and the largest, elements. On prompting showed them. After disguising the smâllest she picked up the 2nd one. On further prompting, identified the smallest. When the largest was disguised she showed the 7th one On asking her to observe the elements again she picked up the 8th one instead of the 9th. Failed to recognize the largest

Non School Going Subjects

1. Raju - 4 Years.

Blocks - Showed the smallest and the largest immediately. When the smallest was disguised, he showed the 2nd one for the smallest. When asked whether it was really the smallest, he showed the 4th one. On prompting he identified the smallest. When asked to show the largest, showed the 8th one which was kept in the place of the largest, i.e., 9th one before the largest was disguised. On prompting showed the largest.

Slats - Showed the smallest at once. For the largest showed the 8th one. When asked to observe the materials once again he picked up the 6th one and quickly kept it back in its place and then picked the 4th one. On prompting he was able to identify the largest, i.e , the 9th one. After disguising the smallest and the largest he confused to recognize both He recognized after some prompting.

Sticks - Showed the smallest easily. For the largest, showed the 8th one. When asked whether it was really the largest, he picked up the 6th one On prompting, identified the smallest. Failed to show the largest. After camouflaging the smallest he confused to recognize it and picked up the 3rd one. When asked whether it was really the smallest, he showed the 2nd one and then the 1st one, i.e., the smallest element. On disguising the largest he failed to recognize it and was confused quite a lot.

2 Sreenivas - 4 Years.

Blocks - Was not confused in identifying the smallest and the largest elements.

Slats - Recognized the smallest and the largest quickly. When the smallest and the largest were disguised showed the smallest quickly but was confused in identifying the largest. On prompting recognized the largest.

Sticks - Showed the smallest and the largest quickly. When the smallest and the largest were camouflaged not able to recoghize the smallest and the largest. Showed the 3rd one for the smallest and the 8th one for the largest. Failed to identify both the elements on prompting.

1. Mahalakshmi – 4 Years

Blocks – She showed the smallest and the largest easily.

Slats – Identified the smallest and the largest when asked to show. When the smallest element was disguised, she recognized easily. But failed to identify the largest when it was disguised and showed the 8th one for the largest.

Sticks – Was confused to show the smallest immediatly. On prompting she was able to identify the smallest Failed to show the largest. When both the elements were disguised she failed to identify and confused. She picked up different elements for the smallest as well as for the largest.

2. Rani – 4 Years

Blocks – Identified the smallest and the largest easily before and after the smallest and the largest were disguised.

Slats – Was not confused in showing the smallest and the largest.

Sticks – Showed the smallest quickly even when it was disguised, but failed to identify the largest before and after it was disguised Showed the 8th one for the largest.

Discrimination items were passed with greater ease by the 5 year old children as compared to the 4 year children The last item in the discrimination test namely pointing the largest one after it was disguised was found to be the toughest problem for children at the 5 year level. As the perceptual cues in discrimination were progressively reduced, i.e., substitution of blocks with slats; and slats with sticks; increased the difficulty level of the task, consequently more subjects failed the items. In the disguise item, subjects usually confused the 8th element with the 9th element, 9th being the largest and 8th immediately preceding it. One prompting most children improved their performance but they appeared to have not grasped the discriminating function. The representative protocols given below would illustrate the performance of subjects.

School Going Subjects

1. Thulasi Ram – 5 Years

Blocks – Identified the smallest and the largest elements immediately even when the elements were disguised.

Slats – Showed the smallest and the largest elements at once and also recognized the smallest and the largest when disguised easily.

Sticks – Picked up the smallest and the largest immediately After disguising showed the smallest easily but confused in identifying the largest. Showed the 8th one for the largest. On prompting picked up the 9th element, i e., the largest one.

2. Chandra Sekhar – 5 Years

Blocks - Identified the smallest and the largest even when they were disguised. Was not confused.

Slats - Showed the smallest and the largest quickly.

Sticks - Showed the smallest but failed to show the largest. For the largest he picked the 8th one. When asked whether it was really the largest he said "yes". Identified the smallest when disguised but failed to recognize the largest.

1. Vishnu Priya – 5 Years

Blocks – Showed the smallest and the largest elements easily even when these two were disguised.

Slats – Was not confused in identifying the smallest and the largest before and after the elements were disguised.

Sticks – Showed the smallest atonce. Confused to show the largest. Picked up the 7th one for the largest. Later, on experimenter's prompting, showed the largest, i.e , the 9th one. Showed the 3rd one for the smallest, when asked to show the smallest after disguising. On prompting she observed the materials for some time and recognized the smallest. Also confused in identifying the largest when it was disguised.

2. Madhavi – 5 Years

Blocks – Showed the smallest and the largest quickly.

Slats – Identified the smallest and the largest before and after they were disguised.

Sticks – Not confused in showing the smallest even when it was disguised Showed the 7th one for the largest and failed to identify it even on prompting Was not able to recognize the largest when disguised

Non-School Going Subjects

1. Nageswar Rao – 5 Years

Blocks – Picked up the smallest and the largest easily even when both the elements were disguised.

Slats – Not confused. Showed the smallest and the largest before and after they were disguised.

Sticks – Showed the smallest immediatly. Confused in showing the largest. Showed 7th one first and then 8th one for largest and failed to show the correct stick. After disguising the smallest showed the 2nd one for the smallest, and was not able to identify it correctly. Also failed to recognize the largest when disguised.

2. Ravi Surya Prakash – 5 Years

Blocks – Identified the smallest and the largest.

Slats – Was not confused in showing the smallest and the largest when they were disguised.

Sticks – Showed the smallest even when it was disguised. Confused in showing the largest but showed the 8th one after disguising the largest. Failed to identify the largest.

1. Anasuya Devi – 5 Years.

Blocks – She identified the smallest and the largest without any confusion.

Slats – Did not exhibit any difficulty to show the smallest and the largest even after the elements were disguised.

Sticks – Showed the smallest at once. Failed to show the largest and picked up the 8th one. After disguising the smallest did not fumble to identify. But was unable to recognize when the largest was disguised. She picked up the 7th one for the largest element.

2. Vijaya – 5 Years.

Blocks – Showed the smallest and the largest easily.

Slats – Identified the smallest and the largest quickly. Recognized the smallest when disguised but failed to show the largest. Showed the 8th one for the largest.

Sticks - Showed the smallest easily before and after it was disguised. But failed to show the largest. Showed the 4th one and then the 7th one for the largest. When asked whether it was really the largest she picked up the 8th one. Could not recognize the largest when it was disguised.

All the 6 year old subjects experienced no difficulty with the first three items of the discrimination test and a few subjects fumbled a little with the 4th item, namely, pointing the largest after it was disguised. The subjects showed no difficulty with the three and two dimensional materials. A few subjects who fumbled a little and required prompting to rectify the errors did so with sticks, i.e., one dimensional material.

At the 7 year age level all subjects passed the discrimination items without any ado. Dimensionality of materials did not adversely affect their performance.

From the above qualitative analysis of the results, it would be seen that children were able to discriminate reasonably well by the time they were 5 year old

Seriation

At the 4 year age level as many as 15 boys committed errors in seriating with blocks. A slightly larger number of girls committed mistakes in seriating with blocks. As many as 30 non-school going girls and 32 non-school going boys committed mistakes which were rectified after some prompting. On asking the children how they seriated no satisfactory answers were obtained. A large majority of children in the groups did not understand the seriation problem. This suggests that at the 4 year level children have not acquired the capacity to seriate. When blocks were substituted by slats more subjects failed in their tasks. The same situation was observed with sticks. The representative protocols would illustrate the position.

School Going Subjects :

1. Ravindra Kumar – 4 Years.

Blocks – Made the stairway choosing the smallest on demonstration with all the 9 elements. Also inserted the 5 extra elements from the second set of materials after the experimenter demonstrated with one of the elements. Inserted the 4 at the appropriate places and fumbled very much in inserting the 5th one, made several seriations and succeeded in making the stairway with the one already constructed.

Slats – Was not able to make the stairway with 9 elements at the first instance. Succeeded in making the stairway with 4, 7 and 9 elements successively. Failed to arrange the stairway with the 5 extra elements into the stairway already constructed. Made several seriations but did not succeed.

Sticks – Failed to make the stairway with 9 elements Made the stairway with 4, 7 and 9 elements successively. While making the stairway with 4 elements he chose the smallest among them first, and placed the 3rd one, next to it, the 2nd one and the 4th one next in that order. On prompting he replaced the sticks and arranged the 4 elements in serial order. Succeeded in making the stairway with 7 and 9 elements respectively. Was not able to insert the 5 extra elements in the stairway already constructed. Inserted them at wrong places.

1. Gowri - 4 Years

Blocks - Made the stairway with 9 elements in the following order: 1, 2, 3, 4, 5, 7, 6, 9 and 8. On pointing the misplacement replaced the F and H stairs at the right places. Could not insert the 5 additional elements into the stairway already made.

Slats - Failed to arrange the stairway at the first instance with 9 elements. Succeeded in making the stairway with 4, 7 and 9 elements successively. Could not succeed in making the stairway with the additional elements.

Sticks - Was not able to make the stairway at the first instance. Arranged the stairway with 4, 7 and 9 elements successively Fumbled while arranging 7 and 9 elements She inserted the 5 additional elements at different positions in the stairway already made disregarding the serial order. On prompting she arranged them into a seperate stairway starting from the other end of the stairway constructed first Failed to insert the 5 extra elements into the stairway.

Non-School Going Subjects

1. Sreenivasa Rao 4 Years

Blocks - Arranged the stairway with all the elements in the following order: 1, 2, 3, 4, 6, 8, 5, 7 and 9 respectively. He was not able to choose the elements in serial order. On prompting, made the stairway correctly. Failed to seriate with the 5 additional elements

Slats - Could not succeed in making the stairway with 9 elements at the first instance Succeeded in making the stairway with 4, 7 and 9 elements successively. While arranging the 9 elements he committed mistakes and later, on prompting, replaced the slats in the correct positions. Failed to insert the 5 additional elements into the stairway.

Sticks - Failed to make the stairway with all the given elements at the first instance. Made the stairway with 4 elements easily. Also succeeded with 7 elements next, but fumbled while arranging them. Could not succeed with 9 elements and made several seriations in order to arrange the stairway.

2. Vijaya Lakshmi - 4 Years

Blocks - Made the stairway easily with all the 9 elements on demonstration. Failed to arrange the additional elements.

Slats - Arranged the 9 elements in the following order: 1, 2, 3, 4, 5, 7, 8, 6, 9. Could not succeed in making the stairway with all the elements at the first instance. Made the stairway with 4, 7 and 9 elements successively. Failed to insert the additional elements.

Sticks - Made several seriations in order to make the stairway with 9 elements. Arranged in the following order: 1, 2, 3, 4, 7, 8, 6, 9 and 5. Succeeded with 4, 7 and 9 elements in constructing the stairway. Was confused while seriating with 9 elements. Could not succeed with the 4th item of the test, i.e., inserting extra 5 elements in the stairway.

A few children could make the stairway with a smaller number of elements like 4. When they were presented with more elements, most subjects were unable to construct the stairway. The children experienced the greatest amount of difficulty with sticks (one dimensionals materials). At the 5 year level there was some improvement in performance but this was not really striking. The children continued to confuse and commit errors in constructing the stairway. Item 4 of the seriation test consisted of inserting additional elements at the appropriate places in the stairway already constructed. Almost all 5 year children could not perform this item correctly. The difficulty of the seriation task increased with the reduction of dimensionality of meterials.

The conclusion that the seriation function is beyond the comprehension of children at the 4 and 5 year age levels appears to be warranted on the basis of the results obtained in the study.

School Going Subjects

1. Ananda Reddy – 5 Years

Blocks – Made the stairway at the first instance with all the elements. Also inserted the 5 additional elements into the stairway, already made, at the appropriate places easily.

Slats – Constructed the stairway quickly. Also inserted the 5 additional elements but was confused in inserting them at the appropriate positions.

Sticks – Made the stairway correctly by choosing the smallest stick each time. While inserting the additional elements he encountered some difficulty. He picked up each stick and compared the length of it with the sticks of the previously constructed stairway and placed it at the right position. When asked him to arrange the stairway without comparing he made several seriations and succeeded.

2. Udaya Kumar – 5 Years.

Blocks – Made the stairway easily at the first instance. Also made the stairway easily when 5 additional elements were given to be inserted into the stairway already constructed.

Slats – Confused while making the stairway. When 5 extra elements were given he arranged them in the following order : aAbBdCcD and e. On prompting he arranged the slats correctly in the following order : aA bB cC dD and e * (Capital letters stand for 1, 2, 3, 4 ... ... 8 of Set. I items, and small letters stand for 1, 2, 3, 4, ... 8 of Set II items).

Sticks – Constructed the stairway at the first instance. Failed to insert the 5 extra elements into the stairway already made. He made several seriations while arranging. He placed the sticks in the following order : cA bB dC eD and f When asked whether it looked like a stairway he said "yes".

1. Sree Priya – 5 Years.

Blocks – Made the stairway with 9 elements easily and quickly. Also inserted the 5 additional elements at the appropriate places.

Slats - While constructing the stairway she committed two errors though she had the idea of size differences. On asking her whether it was like a stairway, after aligning the base of the series into a straight line, she said, "no", and replaced the slats at the appropriate positions. She succeeded in making the stairway with 5 extra elements. Confused while arranging and made several seriations.

Sticks - Made the stairway at the first instance. Committed errors while arranging, and later rearranged them correctly. She arranged the 5 extra elements when asked to insert them in the stairway made in the following order: Aa Bd Cc Dg h. instead of aA Bc Cd Dg h. On prompting she mixed up all the elements and made several arrangements but failed to insert them at the appropriate places.

2. Krishna Kumari - 5 Years.

Blocks - Constructed the stairway easily. Also made the stairway when 5 additional elements were given.

Slats - Was confused while arranging the stairway at the first instance. Made several seriations in order to insert the 5 extra elements at the appropriate positions.

Sticks - Committed errors while arranging the stairway. Corrected on pointing out the errors made. Failed to arrange the stairway with 5 additional elements

Non-School Going Subjects :

1. Venkateswarlu - 5 Years.

Blocks - Made the stairway easily at the first instance. Made a separate stairway with 5 extra elements instead of inserting them at the appropriate places in the stairway already constructed. On further explanation he placed one element at the right place and fumbled to place the rest of the 4 elements at the appropriate positions. Failed in making the stairway with the 5 extra elements.

Slats – Could not succeed in making the stairwry at the first instance. Succeeded with 4, 7 and 9 elements successively. Failed to arrange the stairway with 5 additional elements.

Sticks – Was not able to arrange the stairway with 9 elements. Made it with 4, 7 and 9 elements successively. While seriating with 7 and 9 elements, he fumbled a lot. Was not able to arrange the stairway with 5 additional elements.

2. Ratna Raju – 5 Years.

Blocks – Made the stairway easily. Could not succeed in making the stairway with additional elements. The series he made was as follows : Aa bB CD cd f instead of aA bB Cd De f.

Slats – Made the stairway in the following order : 1,2,3,4, 5,7,6,8 and 9. On promoting he committed a few more errors. Succeeded with 4,7 and 9 elements successively. Was not able to arrange the 5 extra elements

Sticks – Failed to construct the stairway at the first instance. Made with 4, 7 and 9 elements successively. When additional 5 elements were given he inserted them at different positions disregarding the serial order.

1. Nagalakshmi – 5 years.

Blocks – Arranged the stairway easily at the first instance. Arranged a separate stairway with the 5 additional elements. On further demonstration inserted them at inappropriate places.

Slats – Made the stairway at the first instance. Failed to insert the extra elements at the appropriate places. Made several seriations.

Sticks – Was confused very much while seriating at the first instance. Succeeded in making the stairway with 4, 7 and 9 elements successively. Failed to do the 4th item of the test with 5 additional elements

2. Jayamma – 5 years.

Blocks – Made the stairway easily. When 5 extra elements were given she kept them at different places in the stairway already made, disregarding the serial order.

Slats – Seriated all the elements quickly. Failed to make the stairway with additional slats from the second set of the materials.

Sticks – Made the stairway in the following order : 1, 2, 3, 4, 5, 6, 8, 7 and 9. When the errors were pointed out she repeated the same. Succeeded with 4, 7 and 9 elements successively. Failed to insert the extra elements at the appropriate places.

At the 6 year age level children from the school going groups (boys and girls) were all able to make the stairway at the first instance with 9 elements. However, some of the non-school going children were unable to make the stairway in the first instance. They required prompting. With the 4th item of the seriation test namely insertion of additional elements in the stairway, around 50 per cent of the subjects from the school going groups exhibited some difficulty. They resorted to trail and error arrangement. On prompting they eventually succeeded. But the non-school going children exhibited a lot of difficulty with this item. Even at this age level (6 year age level) the dimensionality of materials appeared to play a very significant role. Items with the three dimensional materials were the easiest. Items with one dimensional materials were the most difficult.

School Going Subjets :

1. Madana Mohan – 6 years.

Blocks – Made the stairway quickly and easily at the first instance. When the 5 extra elements were given he inserted them at the appropriate places in the stairway already made.

Slats – Made the stairway with 9 elements easily and also arranged the stairway with 5 extra elements.

Sticks – Made the stairway quickly. Made the stairway with extra elements.

2. Suresh – 6 years.

Blocks – Made the stairway at the first instance. Inserted the 5 additional elements at the appropriate places in the stairway.

Slats – Made the stairway easily. Was confused while inserting the 5 extra elements into the stairway and made a few errors. Later he corrected them.

Sticks – Made the stairway at the first instance. When 5 additional elements were given fumbled and inserted them at wrong places. On prompting arranged them correctly.

1. Sukanya Devi - 6 years.

Blocks - Made the stairway at the first instance. Placed the 5 extra elements at the appropriate places in the stairway. Was not confused while arranging them.

Slats -- Had no difficulty in making the stairway. Also arranged the 5 additional elements into the stairway.

Sticks - She made the stairway with one error, i.e., 1, 2, 3, 4, 5, 6, 8, 7 and 9 and later replaced the 7th after the 6th stick. Was confused while arranging the stairway with 5 additional elements.

2. Harisha - 6 Years.

Blocks - Seriated all the 9 elements at the first instance. When 5 additional elements were given she inserted at the appropriate places quickly.

Slats – Made the stairway easily even when 5 extra elements were given.

Sticks – Was not confused while seriating 9 elements. Inserted the 5 additional elements at the appropriate places easily.

Non-School Going Subjects :

1. Vijayendra Rao – 6 Years.

Blocks – Made the stairway quickly, and also was not confused while arranging the 5 extra elements at the appropriate positions.

Slats - Made the stairway at the Ist instance. He inserted the 5 extra elements in the following order : aA bB dC cD and i instead of aA bB cC dD i. When asked to correct the errors he replaced the salts at the right places.

Sticks - Made the stairway easily. Could not make the stairway with 5 additional elements. He made several seriations and could not succeed.

2. Sambasiva Rao - 6 Years.

Blocks - Seriated all the 9 elements at the first instance. Confused a lot while inserting the 5 extra elements in the stairway.

Slats - Confused while making the stairway with all the 9 elements. Arranged them in the following order: 1, 2, 3, 4, 5, 6, 8, 9 and 7. On prompting, was not able to correct the errors. Succeeded in making the stairway with 4, 7 and 9 elements successively. But failed with 5 extra elements in seriating.

Sticks-Confused while seriating all the 9 elements. Succeeded in making the stairway with 4, 7 and 9 elements successively. Could not succeed with 5 additional elements when asked to insert them at the appropriate places.

1. Rama Devi - 6 Years.

Blocks - Made the stairway quickly at the first instance. Also made the stairway with the extra elements.

Slats - Had no difficulty in seriating the elements into a stairway. Inserted the 5 additional elements at the appropriate places correctly.

Sticks - Made the stairway easily at the first instance. Fumbled to seriate with the 5 additional elements and failed to place them appropriately.

2. Anuradha - 6 Years.

Blocks - Arranged the stairway at the first instance. When 5 extra elements were given, she inserted them in the following order: Aa Bc Ce D bd instead of aA bB cC dD and e. Could not succeed with this problem.

Slats – Though confused initially, made the stairway with all the 9 elements. Was not able to seriate with the 5 additional elements.

Sticks – Failed to seriate at the first instance. Succeeded with 4, 7 and 9 elements successively. Was not able to insert the 5 extra elements at the appropriate places.

At the 7 year age level all children from the school going, as well as from the non-school going groups, were able to make the stairway at the first instance. With the item concerning the insertion of extra elements in the stairway, a small number of children continued to fumble and err. One child made several arrangements and failed to make the stairway with sticks. Irrespective of schooling or no schooling, children at the 7 year age level were able to seriate three dimensional materials with ease. Two dimensional materials also did not pose much difficulty. But small number of subjects confused with one dimensional materials and prompting generally helped them to improve their performance.

School Going Subjects :

1. Hari Krishna – 7 Years.

Blocks – Made the stairway quickly. Also arranged the additional elements at the appropriate places easily. Was not confused in seriating when blocks were substituted by slats and sticks.

2. Madhusudan – 7 Years.

Constructed the stairway and inserted the 5 additional elements at the appropriate places in the stairway constructed with blocks, slats and sticks.

1. Hema – 7 Years.

Arranged the stairway in the serial order easily with blocks, slats and sticks.

2. Jyothi – 7 Years.

Made the stairway at the first instance. Chose the smallest element among the 9 elements at a time and arranged in serial order with blocks, slats and sticks. Not confused while seriating with additional elements.

Non-School Going Subjects :

1. Wilson – 7 Years.

Made the stairway with blocks and slats easily. When slats were substituted by sticks he arranged the 9 elements easily but was confused in seriating with the 5 additional elements. He did not align the bottom of the series in a straight line and on pointing out the errors he corrected them quickly.

2. Sivaji – 7 Years.

Seriated even with the 5 additional elements easily with the different materials viz , blocks, slats and sticks.

1. Padma – 7 Years.

Constructed the stairway quickly even with the 5 additional elements with the three kinds of materials.

2. Sailaja – 7 Years.

Arranged the stairway easily with blocks, slats and sticks. Was not confused while seriating with the 5 additional elements.

The qualitative analysis shows that by the time children reach the 7 year level they are able to seriate reasonably well.

Numeration

At the 4 year level the subjects showed striking differences with regard to the ability underlying numeration. Seventy Five percent of the subjects failed to perform item 4 while most subjects were able to count the stairs. There were marked differences between the school going and non-school going subjects. Employment of slats in the place of blocks added to the difficulty of the subjects and more subjects failed with the numeration tests.

The situation further worsened when the subjects were required to perform with sticks, which indicates that children at the 4 year level would not have acquired numeration skills.

It was seen earlier that the subjects were given a numerosity test and it was found that most children were influenced by perceptual cues. Similarly with number conservation also, subjects at the 4 year level performed poorly.

The 5 year group as a whole showed marked differences between the school going and the non-school going subjects, the former performing better than the latter. The results show that compared with the 4 year old subjects, the 5 year old subjects performed better. This should not be interpreted to mean that at the 5 year level numeration is acquired, - far from it. The 4th item was failed by all the subjects at this age level also. The school going subjects were able to count the stairs the doll had to climb. Most subjects counted upto 4 correctly. But a sizable number of them failed with the 7th stair. When the staircase was disturbed no subject was able to answer the item. The problem of numeration increased progressively in difficulty with the substitution of blocks with slats and later with sticks. The representative protocols produced below show how children at the 5 year level were not able to numerate properly.

School Going Subjects

1. Gajapathi - 5 years

Blocks - Counted the stairs correctly (Item No. 1). Also counted in succession when the dolly was kept on each stair from 1st to 9th (Item No. 2). When the dolly was placed on 4th stair he said it has climbed 3 stairs when it was actually on the 4th stair. When it was placed on the 7th stair he said the dolly has climbed 7 stairs. When the stairway was disturbed he could not recognize 4th and 7th stairs. When the dolly was on the 4th stair he counted all the elements and said that the dolly was on 6th stair. Could not grasp the idea of the problem (Item No. 4).

Slats - Counted correctly. Also succeeded with item Nos. 2 and 3. He failed to recognize 4th and 7th stairs when the stairway was disturbed (Item No. 4).

Sticks - Counted correctly Counted the stairs correctly when the dolly was on 4th stair. When the dolly was on the 7th stair, he said that the dolly was on the 5th stair. When asked to count again he counted correctly and said that the dolly was on 7th stair (Item No.3). Could not succeed with the 4th item of the test.

2. Hemalatha - 5 years

Blocks - Counted correctly. Succeeded with items 2 and 3 of the test. Failed with item 4. She counted all the elements in order to know 4th and 7th stairs.

Slats - While counting, left some stairs and said that there were 6 stairs. On asking her to count again, she counted slowly and correctly. Succeeded with the 4th and the 7th stairs in counting (Item 3). Could not understand item 4.

Sticks - While counting skipped over the elements. On asking her to count slowly she was able to count correctly. Also confused when asked to find out the stair on which the dolly was kept (was on the 7th stair). She said the dolly was on the 6th stair Later, on asking her to carefully, she answered that the dolly was on 7th stair and climbed 6 stairs in order to reach that stair (Item 3). Was not able to understand the problem of 4th item.

Non-School Going Subjects

1 Raja Kumar - 5 years

Blocks - While counting confused and skipped over the elements. He said there were only 7 elements. On asking him to count one by one slowly he counted correctly. Was not able to count correctly in succession. He omitted a few numbers while counting Failed with items 2, 3 and 4.

Slats - Was confused while counting. Counted the some element twice and even thrice in the following order : 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11. He counted the 6th slat twice. He counted correctly on asking to count again. Failed items 2, 3 and 4.

Sticks – Skipped over the elements while counting. When asked how many stairs are there he said "6" stairs When asked to count again he counted aloud in the following order: 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10. He counted the same element twice. On asking him to recount he counted correctly pointing at each stair one by one carefully. Could not succeed with items 2, 3 and 4.

2. Rajeswaramma – 5 years

Blocks – Confused in counting. Skipped some numbers. Failed with items 2, 3 and 4 of the test.

Slats – While counting skipped some elements and said that there were 6 stairs. When the experimenter pointed at each stair she counted them one by one correctly. Was not able to succeed item 2, 3 and 4.

Sticks – Counted in the following order: 1, 2, 3, 4, 6, 8 and 10. She omitted some numbers while counting and skipped the sticks. Was not able to count correctly when asked to count again. Counted in the following order. 1, 2, 3, 4, 5, 6. She skipped over the elements while counting.

The 6 year old subjects showed a remarkable improvement in their performance over their 5 year old counterparts. Even in this group the school going subjects performed better than the non-school going subjects. The non-school going subjects were no better than the 5 year old subjects. This suggests the positive influence of schooling. The non-school going subjects were deficient in counting as well as conservation. A few subjects did not know numbers while most of them counted in a sloppy manner. Some counted the same item twice, some skipped over items while a few could count up to 4 or 5 correctly. The representative protocols given below would illustrate the above.

School Going Subjects

1. Aruna Kumar – 6 years

Blocks – Counted correctly and quickly. Succeeded easily with the items 2 and 3. When the stairway was disturbed (Item

4), he counted from the smallest upto the 4th stair and said that the dolly was on the 4th stair. In order to find out the 7th stair he counted from the smallest among the elements one at a time and while counting so, left the 6th element and counted the 7th stair as the 6th and answered that the dolly was on the 6th stair. When asked to verify he started to reconstruct the stairway upto the 7th in serial order and answered that the dolly was on the 7th stair.

Slats - Counted correctly. Succeeded with 2nd and 3rd items, When the slats were placed in disarry (Item 4) he said that the dolly was on the 4th stair. Was confused in identifying the 7th stair when the dolly was on the 7th stair. He said that it was on the 6th stair. On asking him to verify by counting aloud, he counted aloud and answered that the dolly was on 7th stair.

Sticks - Counted correctly. Succeeded with items 2 and 3 easily. When the dolly was on 4th stair he said that it was on the 3rd stair (Item 4). When asked to see again he counted the stairs mentally by pointing out to each stick and said that it was on 4th stair. When the dolly was placed on the 7th stair he failed to recognize it. Only after reconstructing the stairway upto the 7th stair he was able to answer that the dolly was on the 7th stair.

2. Sreenivasulu - 6 years

Blocks - Counted correctly. Succeeded with items 2 and 3 easily. Also succeeded item 4. Was not confused in recognizing the 4th and 7th stairs. Counted mentally.

Slats - Counted all items correctly. Succeeded with items 2 and 3. Recognized the 4th stair (Item 4) when the dolly was placed on it. To find the 7th stair he counted from the smallest in serial order and said that the dolly was on the 5th stair. While counting he left out 5th and 6th stairs. On prompting he observed the 5th and 6th stairs and counted correctly.

Sticks - Performed the counting problems easily (1, 2 and 3 items). When the stairway was disturbed (Item 4) he recognized 4th stair quickly. When the dolly was placed on the 7th stair he counted and said that it was on the 6th stair. He left out the 6th stair while counting. When asked to verify he counted correctly and recognized the 7th stair.

1. Satyavathi - 6 years

Blocks - Counted correctly. When the elements were in disarray (Item 4) recognized 4th and 7th stairs easily.

Slats - Counted correctly. When the stairway was disturbed (Item 4) recognized that the dolly was on the 4th stair, but was confused to recognize the 7th stair.

Sticks - Counted correctly Succeeded items 2 and 3. Also recognized 4th and 7th stairs when the elements were in disarray (Item 4).

2. Jyothi - 6 years

Blocks - Counted correctly and succeeded items 2 and 3, When the elements were disturbed (Item 4), counted the stairs and said that the dolly was on the 7th stair. Later, on prompting, identified the 4th stair. Counted aloud. Could not identify the 7th stair.

Slats - Item 4. Recognized the 4th stair. When the dolly was actually on the 7th stair she said that it was on the 8th stair. Could not recognize the 7th stair.

Sticks - Item 4. Could not recognize the 4th stair, Reconstructed the stairway in order to know the 4th stair. Failed to recognize the 7th stair.

Non-School Going Subjects

1. Siva Seenu - 6 years

Blocks - Counted correctly. Succeeded the 2nd item. He counted from 1st to 4th stair and said that the dolly has climbed 4 stairs, when the dolly was on the 4th stair. Failed with the 7th stair (Item 3). Was not able to follow the instructions. Failed with the 4th item.

Slats – Was confused while counting. Could not succeed items 2, 3 and 4 of the test.

Sticks – He skipped some elements while counting. Failed to do 2nd, 3rd and 4th items.

2. Murali – 6 years

Blocks – was not able to count in serial order. Omitted some numbers while counting. On asking to count again he was able to count correctly.

Slats – Confused while counting. Failed 2nd, 3rd and 4th items.

Sticks – While counting either skipped the elements or counted the same element twice. On prompting counted correctly. Failed items 2, 3 and 4.

1. Kumari – 6 years

Blocks – Was confused in counting. She was unable to count the numbers in serial order from 1 to 9. On prompting counted correctly. Failed 2nd, 3rd and 4th items.

Slats – In counting skipped over the elements and also omitted some numbers. Could not succeed items 2, 3 and 4.

Sticks – Counted in the following order: 1, 2, 3, 4, 5, 6, 7, 8, 10. Counted correctly on asking to count again. Failed items 2, 3 and 4.

2. Aruna – 6 years.

Blocks – Counted in the following order: 1, 2, 3, 4, 5, 6, 7, 9, 10. Counted correctly on asking to count again. Failed items 2, 3 and 4.

Slats – Confused in counting. Could not succeed items 2, 3 and 4.

Sticks – Counted in the following order: 1, 2, 3, 4, 5, 6, 8, 9. Left one element while counting. On prompting was able to count. Failed items 2, 3 and 4, At the 7 year age level also differences between school going and non-school going subjects persisted. The School going children were able to perform significantly better than the non-school going subjects. For example among the 7 year old boys only 3 subjects failed with item 4 of the numeration test. There were no failures with blocks and slats. In the case of girls however, there were more failures in numeration. Two girls failed the 4th item with blocks, 9 failed with slats and 11 failed with sticks. The non-school going boys at the 7 year age level were no better than the 5 year old subjects. Practically all the subjects did not know to count correctly and failed all the items. The 7 year old girls from the non-school going group also performed in the same way, suggesting that numeration was not acquired by the children in the natural process of development by the time they reached the 7 year level In this regard, the importance of schooling cannot be overemphasized. For example, even at the 6 year age level most children were able to count correctly. Only a very small number of them made mistakes by skipping, counting twice, etc. Item 4 of the test consisted of asking the subject to tell the number of the stair on which the doll was seated after the stairs were disturbed. This item perhaps required abstract memory. The 6 year non-school going group was no better than the 5 year olds. Only 5 among them were able to count correctly. At the 7 year level, the school going boys had no difficulty whatsoever in counting. Almost all children performed the items with blocks easily. With slats a few of them encountered some difficulty. But with sticks more subjects fumbled. The 7 year old school going girls compared favourably with the boys, i.e . there were no sex differences. But with the non-schooling group the position was dramatically changed. For example, only 10 children among the non-school going boys were able to count correctly. Seventy five percent of them failed to identify the 4th and the 7th stairs and not a single subject succeeded with item No. 4. Prompting was not of much avail. The 7 year old non-school going girls compared favourable with the boys. Only 4 among them were able to count correctly and succeeded item No. 4. Representative protocols would illustrate the position.

School Going Subjects

1. Vijaya Sagar – 7 years

Blocks – Succeeded with 1, 2 and 3 items quickly. When the stairway was disturbed (Item 4) identified the 4th and the 7th stairs easily.

Slats – Identified the 4th and the 7th stairs easily when the elements were in disorder (Item 4).

Sticks – Recognized the 4th stair but was confused in identifying the 7th stair when the dolly was kept on it. Counted and said that the dolly was on the 6th stair. While counting missed the 6th stair. He counted again one by one and said that the dolly was on the 7th stair.

2. Murthy – 7 years.

Blocks – Succeeded all the 4 items easily.

Slats – Was not confused.

Sticks – Experienced no difficulty. Did all the 4 items. Counted mentally.

1. Vasanthi – 7 years.

Succeeded all the items of the test with blocks, slats and sticks easily. Counted mentally.

2. Geetha – 7 years.

Performed all the items correctly.

Non-School Going Subjects

1. Lakshmanachari – 7 years.

Blocks – Succeeded only the 1st and the 2nd items. Confused in counting successively. Omitted numbers.

Slats – Experienced the same difficulty with slats.

Sticks – Not able to count quickly. Failed 3rd and 4th items. When asked how many stairs the dolly has climbed to reach this stair (pointing the 4th stair) he counted and said that it has climbed 5 stairs. Failed with the 7th stair.

2. Ramu - 7 years.

Blocks - Counted and performed 1st and 2nd items. Was not able to succeed the 3rd and the 4th items. Said that the dolly was on the 3rd stair when it was actually on the 4th stair (Item 3).

Slats - Confused while counting in succession (2nd Item). On prompting counted correctly. But failed to do 3rd and 4th Items.

Sticks - Confused while counting. Counted in the following order: 1, 2, 3, 4, 6, 7, 8, 9, 10. On prompting counted correctly. Was not able to count serially.

1. Mutyalamma - 7 years.

Was not able to count blocks and slats correctly. Omitted some numbers and skipped some elements while counting from 1 to 9. Failed to count in serial order with sticks.

2. Varalakshmi - 7 years.

Was not able to count all the elements. She was able to count upto 6 only. Failed with items 2, 3 and 4.

From his experiments with children, Piaget discovered the following three stages in classification, seriation and numeration after carefully analysing the performance of children: 1 Global comparison (2 to 5 years); 2. Intuitive (5 to 7 years) and 3. Operational (7 to 11 years). The first two stages may be subsumed under the preoperational stage and the third under the concrete operational stage. With the classification problems, the child in stage I fails to sort the objects into different classes. In the stage 2 the child constructs hierarchical orders, but fails to comprehend inclusion relations. In stage 3 the child understands relation between class and subclass.

In the development of seriation at the first stage (4 or 5 years) children are not able to construct the series. The elements are chosen at random. During the transitional stage i.e., in stage 2 (5 to 6 years) they construct series by trial and error and are not able to make the correct series immediately. In this stage the child sometimes understands ordination which is the child's ability to determine the position of an element in a series and ignores cardination (the ability of the child to differentiate the value of an element in a series i.e , assigning numerical value to an element in the series). In stage 3 (about 7 years and above) the child learns to co-ordinate ordination and cardination and constructs the series suggesting grasp of cardination.

Similarly, in the development of numeration Piaget found the above three stages. The following illustrative examples of behavioural observations would reveal three stages as above :

School Going Subjects

Stage 1 :

Udaya Bhaskar (4.0) - He found out smallest and largest blocks, smallest and largest slats quickly. He showed the smallest stick but when asked to show the largest he picked up the 8th one (immediately preceding the largest). When asked whether it was really the largest, he observed the material and said "no". Then he found the largest one. After disguising it, he picked up the stick that stuck out the farthest and thus failed to identify the largest.

On the seriation test, he arranged the blocks randomly disregarding the size differences. After demonstrating, he made the stairway with 4 elements, next with 7 elements and also with 9 elements. While arranging 9 elements he confused and made several seriations. When asked to make the stairway with 4 slats he chose the smallest each time and arranged the stairway. He was not able to seriate 7 elements, and the seriations test with slats was stopped. When asked to make the stairway with 4 sticks, he confused a lot and made several seriations. He was not able to arrange with 4 sticks. Failed to make the stairway with 7 sticks. So seriation testing with sticks was stopped.

On the numeration test, when asked to count the steps in the stairway (which the experimenter made), he counted in the following order : " 1, 2, 3, 5, 4 ". While counting he skipped some of the elements.

Stage 2 :

Ramesh Reddy (5.3) – He picked up smallest and largest elements before and after they were disguised.

On the seriation test, made the stairway with blocks at the first instance. When E asked to make the stairway with five more blocks from the second set, he (S) built a second stairway alongside the first. Then E demonstrated insertion with one element b. In attempting to arrange the extra elements he placed c in the stairway between b and c. When asked "is it right?" he said "no" and removed c and d. E said "you have to make the stairway with all the nine elements". Then he (S) put them all in, but without any direction. The series was AbB CDadef instead of aAbBcdDef. When asked whether it looked like a stairway, he answered "yes". Made the stairway with 9 slats immediately, but was not able to arrange the extra elements. When asked to make the stairway with all the 9 sticks he seriated them as follows : 1, 2, 3, 4, 5, 6, 7, 9, 8. Then he recognized that it was wrong and rearranged them correctly. Failed to seriate with extra elements.

On the numeration test, he counted the steps in the stairway correctly. When the doll was on the 4th step he said it had climbed three stairs and when it was on the 7th step he said it had climbed 6 stairs. He was able to grasp the idea that the number of stairs climbed could be determined by the number of the stair on which the doll was placed. After breaking up the stairway, he disregarded the order and counted the rest of the elements.

Stage 3 :

Vasu (6.5) – Succeeded all the discrimination items quickly.

On the seriation test, he chose the smallest one first, and each time selected the smallest of the remaining elements. He made the stairway even with extra elements easily.

On the numeration test, he could not count.

On the numeration test, he counted correctly. When the stairway was broken he determined the number of stairs preceded the designated stair (blocks and slats). He confused to determine the 7th stair (with sticks) and while counting he left out the 6th stair and said that the doll was on the 6th stair and 5 stairs preceded it.

Stage 1 :

Farhath Jan. (4.0) – On discrimination test identified smallest and largest elements immediately even when they were disguised.

On the seriation test, she could not arrange the stairway with all the 9 elements (blocks) after demonstration. Arranged them randomly disregarding the size differences. Succeeded with 4 blocks. But she was unable to make the stairway with 7 elements. The series was A B C E D F G (1, 2. 3, 5, 4, 6, 7), So testing for seriation with blocks was stopped. With slats she succeeded in making the stairway with 4 elements. But failed with 7 elements. When 4 sticks were given she was unable to mahe the stairway. The series was A B D C (1, 2, 4,3),. When asked whether it was correct she nodded her head and rearranged the sticks as A C B D (1 3, 2, 4). So seriation testing with sticks was stopped

On the numeration test, she counted the stairs in the following order : 1, 2, 3, 4, 5, 5, 5, 9, 14 (blocks). So the numeration testing with blocks was stopped. Then slats were given and she counted the stairs as 1, 2, 3. 4, 5 6, 9, 8, 10. When stichs were given she counted in this order : 1, 2, 3, 4, 5, 6, 9, 10, 10, 11. She counted the same element twice, i.e., assigned number 4 and 5 to the 4th stair, She also omitted the numbers 7 and 8. When asked to count slowly she counted in this order : 1, 2, 3, 4, 5, 6, 9, 9, 10. Then the testing was stopped.

Stage 2:

Maheswari (5.6) – Showed smallest and largest immediately.

On the seriation test, she arranged the stairway with the blocks quickly. When 5 more elements from the second set were given she arranged a separate stairway alongside the first. When asked whether it was right she said "no". Then she made several seriations and succeeded Similar performance was observed with the slats. With sticks she made the series A B C D E F H I G (1, 2, 3, 4, 5, 6, 8, 9, 7). When the error was shown she replaced the stick G (7) at the correct place When 5 more elements from the second set were given she arranged them in the following order bABdceDfg instead of AbBCdDefg. She failed to insert them at the right places and made several seriations.

On the numeration test, she counted the stairs correctly. When the doll was kept on 4th and 7th stairs she said it has climbed 3 stairs and 6 stairs respectively. After disturbing the stairway, she counted all the elements at random disregarding size differences to find out the designated stair on which the dolly was kept she had no idea.

Stage 3:

K.R. Geetha (7.0) – Succeeded all the discrimination items quickly.

On the seriation test, she chose the smallest item each time and made the stairway. Also inserted the extra 5 elements from the second set and made the stairway quickly.

On the numeration test, she counted correctly. Even after putting the stairway in disarray, she determined the number of stairs preceded the designated stair for all the three kinds of materials by counting mentally.

Non-School Going Subjects

Stage 1:

V. Venkateswarlu (4.3) – He showed smallest and largest among blocks and slats immediately. Showed the smallest stick even after disguising the elements. When asked to show the largest stick he briefly surveyed them and picked up the 8th which was immediately below the largest stick When asked whether it was really the largest he observed the material for some time and showed the 7th one. He could not recognize the largest after disguising.

On the seriation test, he was unable to make the stairway even after demonstration; But succeeded with 4, 7 and 9 elements respectively with blocks. When slats were given he took more than half an hour to arrange the stairway with 4 and 7 elements respectively Failed to make the stairway with 9 elements. So seriation testing was stopped. When sticks were given he was unable to make the stairway even with 4 elements. He picked up the elements randomly and kept them side by side so that the series was BACD (2134). So seriation testing was stopped.

On the numeration test, he could not count. The child did not know numbers.

Stage 2 :

Ratna Raju (5 0) - Identified smallest and largest among blocks and slats. When asked to show smallest and largest sticks he identified smallest and confused to show the largest, and after some time recognized. When the largest was disguised he picked up different elements and failed to identify the largest

On the seriation test, made the stairway with blocks easily, choosing smallest element each time. When 5 more elements from second set were given he made several seriations to arrange them, so that the series was AbaBCDedf instead of aAbBcCdDf. When slats were given he could not make at first instance - the series was ABCDEGFIH (1, 2, 3, 4, 5, 7, 6, 9, 8). Later succeeded in making the stairway with 4, 7 and 9 elements respectively. With sticks also he failed to make the stairway with 4, 7 and 9 elements respectively. He confused very much while arranging the 9 elements.

He could not count on the numeration tests.

Stage 3 :

Venkateswar Rao (7.2) – Identified smallest and largest elements among blacks, slats and sticks before and after they were disguised.

On the seriation test, constructed the stairway at the first instance. When 5 more elements from the second set were given he inserted them at the appropriate places. But while arranging the sticks he fumbled to insert the extra elements and arranged them by removing and replacing the elements.

On the numeration test, he counted correctly. But after mixing up the stairway he was unable to determine the number of stairs that preceded the designated stair. Not understood the problem.

Stage 1 :

Rani (4.5) - Identified smallest and largest elements among blocks and slats after disguising also. Showed the samllest stick immediately when camouflaged. But confused to recognize the largest. In order to identify it, she proceeded to measure the sticks.

On the seriation test, she arranged the blocks in this order: EBCGIAFHD (5, 2, 3, 7, 9, 1, 6, 8, 4). After further explanation she succeeded in making the stairway with 4 blocks. When 7 blocks were given she made the stairway disregarding size relations. When 9 slats were given she arranged them randomly so that the edges of the elements made a regular stepwise pattern. When the experimenter aligned the bottom of the other edge of the elements of the series into a straight line, the tops of the stats no longer made a stepwise pattern. When asked to try again, she arranged them in a stepwise pattern without regard to size relations. After much trial and error activity she made the stairway with 4 elements. When 9 sticks were given she was unable to make the stairway even with 4 elements.

On the numeration test, she could not count.

Stage 2 :

Chandramma (8.7) – Identified smallest and largest immediately (blocks and slats). Though confused to show smallest and largest among the sticks when they were disguised, she recognized them after some time.

On the seriation test, she made the stairway at the first instance with blocks. When five more elements from the second set were given, she constructed another stairway starting from the end of the first. After explanation, she tried to insert them in the completed stairway but could not succeed. She made several seriations. With slats she made the stairway in the following order: ABCDEIGFH (1, 2, 3, 4, 5, 9, 7, 6, 8). Succeeded with 4, 7 and 9 elements respectively. Also arranged sticks into the stairway with 4, 2 and 9 elements respectively. But while constructing with 9 elements she fumbled.

Stage 3 :

Anuradha (6.5) – Performed all the discrimination items quickly.

On the seriation test, constructed the stairway with blocks immediately. When 5 more elements from the second set were given, she inserted them within the completed stairway but without regard to size relations. Also arranged the slats quickly but failed to insert the extra elements. With sticks she made several seriations. Succeeded with 4, 7 and 9 sticks successively.

On the numeration test, she counted correctly. Also counted in succession correctly. When asked how many stairs the doll had climbed to reach the 4th step, she counted all the steps again. She was unable to understand that the number of stairs climbed was determined by the number of the stair on which the doll was placed.

Space was the greatest constraint. The protocols presented in the preceding pages have necessarily been too brief.

Summary

Review of the literature on the subject revealed that work on number concept centred round study of acquisition of counting skills; arithmetic achievement; effects of school curriculum on arithmetic achievement, and the like. However, the acquisition of number concepts and the children's ability to use the numerical operations have not led to any significant research. Piaget's studies concerning conservation, moral judgement and similar others have stimulated researchers and several studies have been reported. Yet, studies regarding number concept have not been as incisive and numerous. This is surprising because Piaget's work with regard to number concepts is considered to be superior to most of his earlier studies. The theoretical background is believed to be much more precise than his earlier theories of cognitive development.

Although the subject (number development) is of fundamental interest, little work has so far been reported in India, in this area (Number concepts). While it is plausible that the studies carried out in the West, may be valid with regard to children from that milieu, one could reasonably worder whether the same would hold good for children in India with its unique cultural and social conditions. This view appears to be reasonable in the light of the suggestion that the course of cognitive development in children is not universal (Mead 1932). Mead stresses the importance of cultural factors in the mental development of children.

The present investigation was concerned with the study of the development of number concept in young children. This was studied in relation to age, schooling or absence of schooling, and mental ability of the children concerned. Relevant hypotheses were set up for examiningt he relation of these variables to the concept under investigation

The population of the study was children in the age group of 4 through 7 years in Tirupati Municipality. Half of the sample of subjects were drawn from among the school-going children and the other half from among the non-school going children. There were 288 subjects in each group.

A 2×3×3×4 factorial design with schooling/no schooling

(2), materials (3), operations (3) and age levels (4) was used. There were 576 subjects in all. Over-sampling, to the extent necessary, was resorted to to obviate the loss of subjects during the course of the investigation. Discarding of data was done whereever neccessary by a random procedure of picking out the unwanted data. Three operations, namely discrimination, seriation and numeration, were studied employing three materials, — blocks (three-dimensional), slats (two-dimensional) and sticks (uni dimensional). The subjects were tested individually employing stricly the same procedure in three sessions with an interval of one week between any two sessions. The experiment involved testing with two sets of materials. The first set of materials was painted orange and the second red. The second set of materials were slightly bigger than the materials in the first set.

The subjects were shown standard demonstrations and were required to make the necessary operations. The experimenter made as exhaustive notes, of operations made by the subjects, as possible

The analysis of data was made for boys and girls as well as for series I and II separately. The data were analysed employing analysis of variance (ANOVA) after testing for homogeneity, and 't' tests were used wherever indicated chi-square test in contingency tables were also used wherever necessary. As the design of the study involved repeated measures of subjects on two variables viz., operations and materials, the data were analysed employing appropriate statistical procedure as suggested by Winer, B.J. (1971) as suitable for a $p \times q \times r$ factorial design with the last two being repeated measures In addition scalogram analysis was made to scale the items in terms of difficulty and phi coefficients were computed for the items. As a supplement to quantitative analysis of data, qualitative analysis was made to obtain greater insight into the processes involved.

The subjects were administered in addition to the above a numerosity test, a number conservation test and a draw-a-man test, the last for assessing mental ability of the subjects. The hypotheses set up were examined in the light of the results obtained.

In the light of the obtained data. The following conclusions appear warranted :

1. Discrimination, Seriation and Numeration operations among young children appear in that order.

2. Children are able to discriminate successfully by the time they reach 4 years of age. Seriation is mastered between 5 to 6 years of age and numeration is attained seldom before 7 years of age.

3. There are significant differences between the school going and non-school going subjects. The non-school going subjects performed poorly on numeration.

4. The non-school going girls performed poorly in comparison to boys at 4 and 5 year age levels with regard to discrimination and seriation operations.

5. The non-school going subjects' performance was uniformly poor with regard to numeration.

6. There were no significant differences between the school going and the non-school going subjects with regard to discrimination.

7. Differences owing to schooling became apparent with regard to seriation operation and the differences were most pronounced with regard to numeration.

8. The experience of schooling appears to play a significant role in the acquisition of number concept especially at the lower age levels.

9 Differences in mental ability seem to play a significant role in the acquisition of number concept. Children with higher levels of mental ability appear to perform better on seriation and numeration However, these differences were not significant with regard to discrimination

10. The dimensionality of materials affects the discrimination, the seriation and the numeration operations positively. Children were able to perform the operations better when more perceptual cues were available to them to discriminate or to seriate or to numerate.

Educational Implications :

The findings of this study adduce support to the 'invariance' theme of cognitive growth. The operations of discrimination, seriation and numeration were achieved by children in that order. A closely related issue, namely, the hierarchical and integrative nature of the cognitive structures was also evident. Most studies reported elsewhere do not present a univocal position in this regard. The studies of Dodwell (1962), Beilin (1965) and others reveal this position. Our results indicate that the cognitive structures involved in the development of Number concept in young children are hierarchical and integrative. It has been argued that this finding is largely related to such variables as age of children the kind of methods employed in the investigation, etc. However, it appears plausible that integrating principles should operate in the development of cognitive structures. A child at a higher age should be able to perform all the operations, he could at the lower age levels.

Granting that hierarchical and integrative structures are developed in an invariant sequence, the questions, How they come to develop? The processess that are involved; and the factors which contribute to such development; would be very important and promising area of investigation. As students of psychology, we could reasonably be interested in the psychological variables that could possibly affect cognitive growth. What kind of experiences are necessary for the acquisition of a given concept, is an issue of momentous importance. It was seen that children at different age levels failed different problems. How shall these individual variations be explained? It was also seen that one group of children differed significantly from another group of children (the school going children and the non-school going children). How are the inter-group differences in addition to intra-group differences to be explained? We are naturally tempted to exploit such factors as age, environment, experiencer, etc., to account for the observed differences. It is necessary to examine the implications of these observed differences.

Anthropologists, sociologists and psychologists have attached great importance to cultural factors affecting people's behaviour. Behaviour is influenced by environment ; and culture as the man-made part of the environment, could be expected to affect the modes of thinking and acting It is easy to appreciate that the child bred and brought up in West European countries would be exposed to cultural milieu strikingly different from that affecting the child from oriental cultures. Several studies have reported consistencies as well as variations in the growth of cognitive structures in children belonging to diverse cultures. (Goodnow (1962). Greenfield (1966) and others.

Not only are these differences limited to such broad aspects as oriental-occidental backgrounds, but we find that there could be variations in the cultural backgrounds of upper- and lower-social class children. The significant results namely differences between school going and non-school going children adumbrate the importance of cultural differences. The results corroborate those reported by Mermelstein and Shulman (1967) with lower class schooled and unschooled Negroes Goodnow (1962) explains these differences as arising from social class belonging. The studies alluded to above, suggest that social and cultural factors play a significant role. Students of social anthropology have drawn attention to such interesting differences as the surprising navigational skills of the Polynesian children and the amazing fishing skills of the Eskimo children. How do the cultural backgrounds of these children help their acquisition of such competencies? Studies such as those of Almy, Chittenden and Miller (1966) report that lower-class children show conservation of quantity and number much later than the upper-class children. Reporting of such findings does not accomplish anything more than stating an empirical fact. What would perhaps, be helpful is the explanation of how such variations are caused ? — And a plausible explantion is yet to be found !

The non-school going groups have been found to perform poorly. What experiences and factors in their environment have contributed to this outcome? Perhaps it would help us to understand the situation, if the home backgrounds of the children are explained. The non-school going children are those belonging to socio-economically lower-class families. Among other things, the children have handicaps arising from belonging to the lower-class groups. Bernstein (1961 b) has drawn attention to language limitations and deficiencies arising from restricted environments of the lower-class groups. That language plays a significant role in the development of cognitive skills have been stressed by several psychologists like Bruner, Goodnow, Greenfield, to mention a few. The schooling experiences provide for, the need for use of certain kinds of skills like use of numbers. And the lower-class children who cannot avail themselves of schooling, have no compelling need to acquire and exercise skills such as the use of numbers. The school going children are exposed to and stimulated by such situations that require classification, seriation and numeration which help the growth of the concept of cardinal number.

Another important aspect of schooling experience is the play activities of children. The upper-class children have opportunities to play with such materials that provide them with stimulating experiences conducive to the development of certain kinds of cognitive skills. The lower-class children also play but what is important is that they play different kinds of games and with different types of materials. For instances, girls play house keeping games with make-believe house hold articles and boys play none too different games. On the other hand, the children from upper-classes play with materials that are designed to stimulate cognitive development. Schooling reinforces further such experiences which unfortunately a non-school going child is denied. The school curriculum, i.e., class-room teaching, play, work experience, etc., provide for manipulations of objects which not only stimulate cognitive growth but also provide feed-back data. Other intra-group differences could perhaps be understood in terms of individual differences such as rate of growth, mental ability, and other similar factors. The findings of this study have shown that superior children were able to acquire the concerned cognitive structures earlier i.e , acquire them faster than children of lower ability. The implications of the findings appear to be far reaching.

Four basic factors are understood to be involved in the acquisition of concepts. The first of them viz., maturation is of vital significance. This is reflected in the significant differences in the performance of children at different age levels. Older children generally exhibit superior performance. The second factor, viz., experience, is a crucial one. This is brought to light in the differences exhibited by the school going and non-school going children. The third factor viz., learning through social transmission is brought to fore by the differences between upper and lower class children. Upper-class children have developmental environments which are 'elaborate' as contrasted with that of lower-class children whose environments are restricted. Naturally precious little social transmission takes place. The last point stressed by Piaget and his associates is what is known as equilibration. This provides for self-regulation. Lorenz maintains that a simple act as driving a nail is an act which no sub-human species could perform because there is no possibility for equilibration or compensatory actions or adjustive reactions for minor and minute differences and changes. It is through equilibration that cognitive structures are modified. In this context educational or learning experiences could be said to assume great significance. There is need for the right type of experiences which could be provided at the appropriate time. We have seen that an operation, such as, discrimination is performed comparably well by all subjects by the time they are 5 years old. This is largely owing to the fact that discrimination is fundamentally dependent on perceptual cues. Errors, if any, occur owing to non-perception of the cues. Younger children are not able to attend to details for they are more distractible. Older children can hold their attention reasonably longer so as to perceive the available cues. The other operations viz., seriation and numeration are not entirely perception bound. The first involves the rudimentary form of the ordinal number and the second involves cardination.

Experience is necessary for cognitive development. When children move from the sensori–perceptual stage to the stage of concrete operations through pre–operational stage, the experiences that make for 'assimilation–accommodation' help smooth and speedy progression from a lower to a higher stage. The learning experiences should be so designed as to stimulate and challenge the child such that his ‘schemata’ could become more inclusive and accommodative through assimilation of subsidiary schemas.

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